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Volume 19, Number 10, May 31, 1965

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NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

Refer also to abstract 18351.

17444 (UR-660) A MEMBRANE-FILTER TECHNIQUE FOR ENUMERATING MEGAKARYOCYTES. J. E. Traynor and M. Ingram (Rochester Univ., N. Y. Atomic Energy Project). Dec. 15, 1964. Contract W-7405-eng-49. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A procedure for counting megakaryocytes in bone marrow specimens is described. After lysis of the red cells, megakaryocytes from a known aliquot of marrow are collected and stained on a membrane filter and mounted. The megakaryocytes are easily identified and counted on the preparation using the low power lens of the conventional microscope. Although most of the samples studies in developing this method have been dog bone marrow, experience with a limited number of human marrow specimens suggests that the method can probably be applied successfully to humans as well as other mammals. (auth)

17445 SIXTH INTERNATIONAL TRANSPLANTATION CONFERENCE, FEBRUARY 6, 7, AND 8, 1964. PART I. Harold E. Whipple, ed. Ann. N. Y. Acad. Sci., 120: 1-806 (Nov. 30, 1964). (CONF-641113(Pt.I))

Separate abstracts were prepared on seven papers. Other papers discussed various aspects of immune reactions to tissue transplants. (C.H.)

For abstracts of individual papers see: 17446, 17447, 17503, 17504, 17505, 17506, and 17668.

17446 HETEROTRANSPLANTATION OF HUMAN ANTIBODY-FORMING CELLS IN DIFFUSION CHAMBERS. N. Gengozian (Oak Ridge Inst. of Nuclear Studies, Tenn.). Ann. N. Y. Acad. Sci., 120: 91-118(Nov. 30, 1964).

The in vivo diffusion-chamber technique was used for cultivation of human lymph node, spleen, bone marrow, and peripheral white blood cells in studying their capacity to form antibody against a test antigen. Cell suspensions were mixed in vitro with the antigen, S. typhosa, in a known quantitative ratio of antigen to cells. Aliquots of this mixture were placed in diffusion chambers, which were then implanted intraperitoneally in irradiated mice, the latter serving as an in vivo tissue culture medium for the human cells. With either lymph node or spleen cells in such a system, it was possible to induce active antibody synthesis against the specific test antigen during a maximum cultivation period of 14 days. The synthesis of two human serum proteins, gamma, and β-2M globulin, was demonstrated by the Ouchterlony reaction and immunoelectrophoretic analysis of the chamber fluids. The presence of antibody in the cultured cells was demonstrated by specific immunohistochemical staining, using the flagellin protein antigen and a fluorescein conjugated rabbit antiserum in the double-layer technique. Inactivation of the anti-H agglutinins found in the chamber fluids by in vitro incubation with 2-mercaptoethanol indicated that the antibody activity was associated primarily with the macroglobulin protein. Analysis of the lymph node cells during chamber cultivation showed cytologic and morphologic changes leading to formation of blast-type cells and proliferative activity. These cellular changes were generally evident on the fourth or fifth postimplantation day, and showed peak activity approximately one week after cultivation. Formation of similar blast-type cells and associated mitotic activity was obtained with cultivation of peripheral white blood cells, although these cellular changes developed later and in smaller numbers than that observed with lymph node cell cultivation. Antibody formation to the test antigen by either peripheral white blood cells or bone marrow was negative in this system. The cultivation of human lymph node or spleen cells in the foreign murine environment resulted in the formation of antihost antibodies detectable in the chamber fluids as mouse RBC agglutinins. The specificity of these antibodies for host antigens as distinct from the typhoid-antityphoid system was demonstrated by suitable absorption tests. Preservation of human lymph node cells having immunologic potential was effected by controlled rate freezing of the cells and subsequent storage at liquid-nitrogen temperatures. (auth)

17447 ELUTION FROM SPECIFIC AGGREGATES OF THE RABBIT ANTIBODY CAUSING SUPPRESSION OF TRANSFERRED RABBIT LYMPH NODE CELLS. T. N. Harris, Clifton A. Ogburn, Susanna Harris, and Miriam B. Farber (Children's Hospital, Philadelphia and Univ. of Pennsylvania, Philadelphia). Ann. N. Y. Acad. Sci., 120: 129-39(Nov. 30, 1964).

By sonic oscillation and differential centrifugation, a fragment was obtained from washed rabbit lymph node cells which fixed complement with rabbit anti-rabbit-leukocyte sera and absorbed from such sera the antibody which causes suppression of transferred lymph node cells. A similar cell fragment could be obtained from wash fluids of lymph node cells and splenic cells and, in substantially lower concentration, from wash fluids of liver cells. The prior injection of these cell fragments into prospective recipients of transferred antigen-incubated lymph node cells caused rejection of the cells, as indicated by the failure of antibody to appear after transfer of the lymph node cells. Also, the injection of cell fragments into rabbits led to the production of antibodies which could cause suppression of lymph node cells if these cells were incubated with the serum prior to transfer. The suppressive antibody which had been absorbed from antileukocyte serum by the cell fragments could be dissociated from these fragments by a low-pH buffer with a recovery of about 25 per cent. The antibody in this eluate showed properties of a pseudoglobulin. It could be adsorbed to and eluted from CM cellulose and ECTEOLA cellulose. In the latter case, evidence of some nonsuppressive-antibody protein in the eluate was obtained, and, within the suppressive antibody, some evidence of heterogeneity. (auth)

17448 INTERNATIONAL REVIEW OF CYTOLOGY. VOLUME 16. G. H. Bourne and J. F. Danielli, eds. Intern. Rev. Cytol., 16: 1-345(1964). New York, Academic Press, 1964.

Separate abstracts were prepared on two chapters. Other chapters discuss various aspects of cytology including the relation of ribosomes to protein synthesis, chloroplast formation in Euglena, the relation of cell structures to ameboid movement, in vivo studies of myelinated nerve fibers, and the cytology of respiratory tissue. (C.H.)

For abstracts of individual chapters see: 17565 and 17566.

17449 HYBRID CELLS DERIVED FROM MOUSE AND MAN: ARTIFICIAL HETEROKARYONS OF MAMMALIAN CELLS FROM DIFFERENT SPECIES. Henry Harris and J. F. Watkins (Oxford Univ.). Nature, 205: 640-6(Feb. 13, 1965).

Properties of heterokaryons that were produced by fusing together cells of human and murine origin are described. The two cell types used were HeLa cells (originally derived from a human carcinoma) and mouse Ehrlich ascites tumor cells. The virus used was a strain of Sendai virus, which was inactivated against virus production by uv light. In the presence of virus, the two cells clumped immediately, and the size of the clumps was roughly proportional to the amount of virus added. The cells in the clumps underwent varying degrees of fusion. After incubation, it was found that multinucleate cells accounted for about 10% of the single cells originally present in the suspension. Each of the multinucleate cells contained from 2 to about 20 nuclei. The nuclei were of two easily distinguishable morphological types. The method by which it was concluded that the multinucleate cells were formed by fusion of the two cell types is described. At least 98% of the multinucleate cells were heterokaryons when virus concentrations of 8,000 hemagglutination unit/ml or more were used to induce the cell fusion. The resulting hybrid cells synthesize protein, and both sets of nuclei synthesize RNA, therefore these hybrids can be used to investigate problems of nucleocytoplasmic relations. (P.C.H.)

17450 NEOPLASMS IN THYMECTOMIZED MICE FOLLOWING ROOM INFECTION WITH POLYOMA VIRUS. Lloyd W. Law (National Cancer Inst., Bethesda, Md.). Nature, 205: 672-3(Feb. 13, 1965).

The effects of early thymectomy on the development of spontaneous mammary cancer in the females of a high mammary tumor strain were investigated along with the effects of thymic removal of methylcholanthrene-induced fibrosarcomas in their male littermates. C3H/HeN strain mice from the NIH colony were used. They were thymectomized at 3 days of age. The mice were housed in an animal room containing other experimental mice, some of which had received polyoma virus parenterally. Females received no further treatment; males received 0.1 mg of 3-methylcholanthrene (MCA) dissolved in 0.2 ml tricaprylin, subcutaneously, at 8 weeks of age. The results indicate that thymectomy at 3 days appears to be more effective than x irradiation in inducing polyoma type neoplasms. The findings are in accord with the concept that the basis of resistance to polyoma virus oncogenesis is a cellular immunity of the homograft type directed against virus-specific new antigen contained in the neoplastic cells. (P.C.H.)

17451 DIRECT AGAR ISOLATION OF MYCOPLASMAS FROM HUMAN LEUKAEMIC BONE MARROW. Leonard Hayflick and Hilary Koprowski (Wistar Inst. of Anatomy and Biology, Philadelphia). Nature, 205: 713-14(Feb. 13, 1965).

Mycoplasmas were isolated from broth cultures seeded with three bone marrow samples obtained on the same day from one of three children suffering from acute lymphoblastic leukemia. The method used is described. The properties of mycoplasmas are discussed and make it interesting to speculate on the part that mycoplasmas may play in the aetiology of human leukemia since presence of the microörganisms in bone marrow may result in changes in the regulation of myelopoiesis. (P.C.H.)

Ecology

17452 (HW-SA-3454) DEMISE OF SAGEBRUSH THROUGH NATURAL SOIL CHANGES. W. H. Richard (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Mar. 31, 1964. Contract [AT(45-1)-1350]. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The demise of sagebrush on a few acres of desert steppe habitat in southeastern Washington is attributed to natural changes in a soil profile that have tended to increase the sodium content of the soil and to alter soil moisture relationships. (auth)

17453 (JPRS-28560) ON THE MIGRATION OF STRONTIUM-90 AND CESIUM-137 IN THE HUMAN ORGANISM FROM CONSUMPTION OF SOME FORMS OF MARINE ANIMALS. O. G. Mironov. Translated from Okeanologiya, [4]: 1059-61(1964). 4p. (TT-65-30243). $1.00 (CFSTI).

A comparison of data from international fish catch statistics and data on the radioactivity of commercial marine animals indicates that the intensity of migration of ^{90}Sr and ^{137}Cs onto the land with catches of marine commercial animals is insignificant as a biogeochemical process. However, the quantity of ^{90}Sr and ^{137}Cs removed from marine commercial organisms and concentrated directly into the human food ration is a substantial additional source of internal irradiation of the human organism. (C.H.)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstracts 17738, 18140, and 18270.

17454 (LA-DC-6384) SYNCHRONIZED MAMMALIAN CELLS IN SUSPENSION CULTURE. D. F. Petersen and E. C. Anderson (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract [W-7405-eng-36]. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

High yields of synchronized mammalian cells in suspension culture were obtained by reversible interference with DNA snythesis through introduction and removal of high concentrations (1 to 25 mM) of thymidine or deoxycytidine at two specified intervals. Appropriate spacing of blockade and release resulted in segregation of the entire population into a single phase of the life cycle. Upon release from the second deoxynucleoside blockade, a synchronous wave of cells comprising up to 100 percent of the population underwent mitosis within a period of approximately 4 hours. This degree of synchrony is sufficient to permit detailed investigations of molecular events occurring within any of the major areas of the cell life cycle. (auth)

17455 MORPHOLOGIC CHANGE AND THE DNA CONTENTS OF THE TESTICULAR CELL OF RABBITS TREATED WITH THE FATTY ACID EXTRACTED FROM THE IRRADIATED ANIMALS. Michio Yamamoto, Sumikazu Kojima, Jun-ichi Tanimoto, Shigeo Nobuki, Akira Hagitani, Soichi Nishishita, Midori Shiwaki, and Kozo Utsumi (Okayama Univ., Japan). Acta Med. Okayama, 14: 68-76(Apr. 1960).

The unsaturated fatty acid fraction (OX) from the liver of irradiated rabbits contains a substance that has the same effects as x irradiation on the testicular cells. This substance introduced intravenously caused the degeneration of the germinal cells with the formation of giant cells or multi-nucleated cells and the mitotic abnormalities. The DNA content of the cell also showed the changes exactly identical with that seen after x irradiation. From the results it was concluded that the x-ray injury will be mainly due to the production of some toxic substance that is found

in the unsaturated fatty acid fraction and severely affects the cells in mitosis and DNA metabolism. (auth)

17456 EFFECT OF PAPAVERINE ON THE ^{86}Rb UPTAKE OF THE ISOLATED KIDNEY. T. Harza, G. Koever, M. Malyusz, and L. Harsing (Univ. Medical School, Budapest). Acta Physiol. Acad. Sci. Hung., 24: Suppl., 50(1964).

The changes in ^{86}Rb uptake of the isolated dog kidney in response to papaverine were studied by injecting ^{86}Rb directly into the renal artery and measuring the activity of the outflowing blood by means of a β-sensitive GM counter. Renal ^{86}Rb uptake was calculated from the difference between the injected and outflowing activities. It was found that in response to the simultaneous injection of 20 mg papaverine/min into the renal artery the renal ^{86}Rb uptake was reduced to one-half to one-third the control value. Considering that papaverine has no direct influence on the ^{86}Rb uptake of tissues, it is concluded that in response to papaverine some of the blood passes over directly from the arterial to the venous system of the kidney, bypassing the capillaries. (BBB)

17457 ^{59}Fe UPTAKE OF RABBIT BONE MARROW ERYTHROID CELLS IN VITRO: THE ENERGY DEPENDENCE OF THE PROCESS. Olga Geszti, F. Antoni, and I. Arky (Hungarian Army Medical Corps and Frederic Joliot-Curie National Research Inst. for Radiobiology and Radiohygiene, Budapest). Acta Physiol. Acad. Sci. Hung., 24: Suppl., 57(1964).

Iron-59 was used to study the ability of bone marrow cells to divide and differentiate in vitro; ^{59}Fe was found to be a suitable means for studying their differentiation. The ^{59}Fe uptake of the rabbit bone marrow cells was measured in a medium consisting of 20% homologous serum in Tyrode's solution. The medium contained 10^7 nucleated cells/ml ^{59}Fe citrate solution added. The ^{59}Fe activity of the cells was expressed as the ratio of the total activity administered and the activity taken up by the cells, related to the erythroid cell count. It was found that the ^{59}Fe uptake by the cells depended on the temperature and was influenced by treatment with agents inhibiting glycolysis and oxidation (F^-, dinitrophenol). (BBB)

17458 EFFECT OF THE TISSUE ERYTHROPOIESIS-STIMULATING FACTOR (ESF) ON THE ^{59}Fe INCORPORATION INTO THE BONE MARROW, IN VITRO. Anna Doeklen (Frederic Joliot-Curie National Research Inst. for Radiobiology and Radiohygiene, Budapest). Acta Physiol. Acad. Sci. Hung., 24: Suppl., 58-9(1964).

Under hypoxic conditions all tissues are able to produce ESF. The site of action of tissue ESF was studied. Two samples were prepared from the same lung homogenate, each of them containing fresh bone marrow from rats. One of the lung tissue samples was previously kept under reduced pressure for 3.5 hr, the other under atmospheric pressure (control). The ESF effect was measured by the rate of ^{59}Fe incorporation into the erythroid elements of the bone marrow (0.5 μC/50 to 70 million cells). After incubation of the samples the incorporated ^{59}Fe was isolated and determined as hematin. The sample from the lung homogenate kept under reduced pressure incorporated 43% more of ^{59}Fe than did the control sample. The results indicate that hemoglobin synthesis in bone marrow is increased by pulmonary ESF which exerts the same effect as serum ESF. This experimental system is suitable for determining the ESF activity of the different tissues. (BBB)

17459 PENETRATION OF P^{32} INTO ERYTHROCYTES UNDER DIFFERENT CONDITIONS OF CONSERVATION. Tadeusz Dorobisz, Stanislaw Przestalski, Edward Bielinski, Mieczyslaw Kilian, and Julian Olearczyk. Acta Physiol. Polon., 15: 839-44(1964). (In Polish)

The penetration of radiophosphorus ^{32}P into the erythrocytes of conserved blood with different contents of plasma was studied. Four rows of conserved blood samples were set up. The first row consisted of conserved full blood; from the samples of the second row plasma was withdrawn in amounts corresponding to $^3/_{10}$ of the volume of the full blood; in the third row $^3/_{10}$; and in the fourth row $^4/_{10}$. The experiments lasted 25 days, during which time 7 measurements were made. Significant differences in the penetration of ^{32}P into the erythrocytes related to the proportion of plasma or to the time of storage of the blood were not found. A second series of experiments was concerned with the effect of addition of largactyl and quinine to the stabilizer of conserved blood on the penetration of ^{32}P into erythrocytes. The observations were made at intervals of several days during 73 days' storage of the blood. Significant differences related to the composition of the conserving fluid or time elapsing after conservation of the blood were not found. It was concluded that study of the ability of ^{32}P penetration into erythrocytes is not a reliable method of ascertaining changes in the erythrocytes taking place during storage. The findings indicate penetration of phosphate ions into the erythrocytes by diffusion, unrelated to the glycolytic metabolism of the erythrocytes. (auth)

17460 THE METHOD OF ISOTOPIC EQUILIBRIUM. F. Chevallier (Commissariat à l'Énergie Atomique, Saclay, France). Ann. Nutr. Aliment., 17: B51-70(1963). (In French)

The application of isotopic equilibrium methods to the problem of renewal of biological systems was developed. Theory was developed for an organism in a stationary state, and several cases of the origin of constituents were considered: constituents of exogenous origin, those of mixed endogenous and exogenous origin, and those of endogenous origin. The second case was considered in most detail. For the rat, a diet of 0.120% cholesterol (1000 cpm/mg) produced a level of about 400 cpm/mg of serum cholesterol in 24 days. Organs could be divided into three categories according to the ratio of their equilibrium cholesterol specific activity with that of serum cholesterol. One group showed a ratio near 1; another, near 0.5; and the brain, nearly 0. Data are also presented for the proportion of cholesterol replaceable or irreplaceable by serum cholesterol for the organs of the rat and for the whole organism. The time for reaching equilibrium was 19 to 24 days in the rat whether a diet containing 0.025%, 0.120%, or 0.520% cholesterol (1000 cpm/mg) was used. In these cases the equilibrium specific activity of serum cholesterol was about 90 cpm/mg, 180 cpm/mg, and 650 cpm/mg respectively. The specific activity of serum and fecal steroids of rats receiving daily subcutaneous injections of cholesterol-4-^{14}C was plotted as a function of time. Some attention is also directed to the growing organism; three consecutive equilibria were seen here. (BBB)

17461 CHARACTERISTICS OF VARIOUS TYPES OF CLOSTRIDIUM BOTULINUM THAT LEAD TO DIFFERENT FOOD PROCESSING AND HANDLING REQUIREMENTS. L. L. Kempe (Univ. of Michigan, Ann Arbor). Assoc. Food Drug Officials U. S., Quart. Bull., 28: 199-206(Oct. 1964).

A brief discussion is presented on the disease botulism, including some characteristics of the organism Clostridium botulinum as well as differences between various types of the bacterium and their toxins. These are related to food poisoning, which in turn is discussed in context with food processing, storage, and distribution. Radiosensitivity of the bacterium is also included. (P.C.H.)

17462 EFFECT OF COENZYMES ON THE HYDROGEN–DEUTERIUM EXCHANGE OF CHICKEN HEART LACTIC DEHYDROGENASE AS MEASURED BY INFRARED SPECTROPHOTOMETRY. Giovanni Di Sabato and Martin Ottesen (Carlsberg Lab., Copenhagen). Biochemistry, 4: 422-8(Mar. 1965).

The deuterium exchange of the peptide groups of lactic dehydrogenase from chicken heart was studied at pH 6.9 in the absence or in the presence of various coenzymes. The exchange was measured by the decrease in absorbancy of the Amide II band (1552 cm^{-1}). Native chicken heart lactic dehydrogenase has about 50% fast-changeable peptide hydrogens, about 15% slowly exchangeable, and about 35% hard-to-exchange peptide hydrogens. All the coenzymes tested decreased the hydrogen exchange of the native enzyme. The protection given by the reduced nicotinamide-

adenine dinucleotide apparently consists in a decrease of the rate of exchange of the slowly exchangeable hydrogens, while the oxidized nicotinamide-adenine dinucleotide and the reduced and the oxidized 3-acetylpyridine-adenine dinucleotides appear to decrease the rate of exchange of the fast-exchangeable hydrogens. Sodium dodecylsulfate greatly enhanced the hydrogen exchange of the enzyme. The coenzymes tested also partially counteracted the increase in hydrogen exchange induced by sodium dodecylsulfate: the reduced coenzymes and the 3-acetylpyridine analogs exerted a stronger protection than did the oxidized and natural coenzymes, respectively. The results are interpreted as suggesting conformational changes induced by the coenzyme of chicken heart lactic dehydrogenase. (auth)

17463 CARBOHYDRATE METABOLISM IN THE SAPWOOD OF POPULUS DELTOIDES. S. A. Edwards and A. T. Wilson (Victoria Univ. of Wellington, N. Z.). Biochim. Biophys. Acta, 97: 340-1(Feb. 15, 1965).

A ^{14}C dating method was used to examine the carbohydrate metabolism in the sapwood of Populus deltoides (an angiosperm). The cellulose laid down by a tree in any one year will have the same ^{14}C specific activity as the atmosphere at that time (since the carbon of the cellulose comes from atmospheric CO_2), and once formed cellulose is not involved in later metabolic activities of the tree. Therefore it is possible to determine whether the water-soluble material of a tree is stable or in dynamic equilibrium with the metabolism by counting the ^{14}C activity of starch and cellulose in each annual ring. The results showed that very little starch from later years had been incorporated into the 1953/54 and 1954/55 annual rings, i.e., that there was negligible turnover in the starch reserves of P. deltoides. (P.C.H.)

17464 BLOOD KETONE RESPONSE TO NOREPINEPHRINE-INDUCED FREE FATTY ACID ELEVATION IN DIABETES. William G. Blackara and Yoshiaki Omori (Atomic Bomb Casualty Commission, Hiroshima). Diabetes, 13: 518-26(Sept.-Oct. 1964).

Eleven non-diabetic and 41 adult-onset diabetic subjects were selected from the Atomic Bomb Casualty Commission (ABCC) clinic populations and the Hiroshima University Hospital wards. During ninety-minute norepinephrine infusions, blood free fatty acid and ketone responses of Japanese nondiabetic and diabetic subjects were determined. Non-obese diabetic subjects with and without fasting hyperglycemia demonstrated significantly greater blood ketone elevations than nondiabetics. An inverse correlation between obesity and blood ketone response to norepinephrine was observed in diabetics. This correlation could not be attributed to varying degrees of fasting hyperglycemia or free fatty acid elevation. Non-obese diabetics with mild fasting hyperglycemia (90 to 150 mg per 100 ml) exhibited an unexpected greater increase in blood ketones than nonobese diabetics with moderate fasting hyperglycemia (150 to 250 mg per 100 ml). Differences in free fatty acid elevations were not responsible for this apparent paradox. The magnitude of the hyperketonemic response, though dependent on free fatty acid elevation, seemed more sensitive to the degree of obesity and the fasting blood glucose level. Fractional ketone body measurements indicated that the blood ketone elevations were predominantly due to β-hydroxybutyric acid increases. (P.C.H.)

17465 STUDY OF A NEWLY DISCOVERED ACTION OF 5-HYDROXYTRYPTAMINE: INHIBITION OF ^{131}I UPTAKE IN THE RAT. A. D'Addabbo, R. Giorgino, and G. Fanfani (Università, Bari, Italy). Folia Endocrinol. (Rome), 16: 577-90(Oct. 1963). (In Italian)

Experiments were conducted in adult Wistar rats treated with serotonin (5-hydroxytryptamine, 5-HT) according to various dose schedules. The first group received a single subcutaneous injection of 20 mg/kg 5-HT (as the creatinine sulfate); the second group was injected every other day with 2.5 mg/kg for 10 days; the third group received 5 mg/kg doses every other day for 20 days; and the fourth group served as controls. All groups were injected intraperitoneally with $Na^{131}I$ (2 μC) and thyroid radioactivity was followed at 6, 24, and 48 hr after this injection. Thyroid activity, as measured by thyroid ^{131}I uptake and plasma protein-bound ^{131}I (PBI), was not changed in the first group as compared with controls. In the second group the ^{131}I thyroid uptake was reduced 35% at six hr, plasma radioactivity was increased, and PBI decreased. Depression of thyroid activity was even greater in the third group, thyroid ^{131}I uptake being almost completely abolished, plasma act. increased, and PBI markedly decreased. Body weight and thyroid gland weight were not significantly altered in the experimental groups, but histologic evidence of atrophy of thyroid parenchymal cells was seen. No increase of urinary excretion of 5-hydroxyindoleacetic acid, a metabolite of 5-HT, was detected. (BBB)

17466 RETENTION OF ^{85}Sr IN RATS AS INFLUENCED BY CALCIUM-ACTIVATED BARIUM SULPHATE. V. Volf (Inst. of Industrial Hygiene and Occupational Diseases, Prague). Intern. J. Radiation Biol., 8: 509-11(1964).

Various amounts of barium sulfate were administered orally to starved adult rats at different time-intervals after ^{85}Sr contamination in order to lower its retention in the organism. Under optimal conditions, when 1.6 mM calcium-activated barium sulfate alone or in combination with sodium sulfate were given immediately after ^{85}Sr ingestion, the average skeletal content was reduced by more than 99% in comparison with controls. Thus after two days, less than 0.2% of administered ^{85}Sr was estimated to be retained in the whole skeleton of treated animals. However, the effectiveness of the calcium-activated barium sulfate decreased sharply with the time that elapsed from ^{85}Sr contamination till the beginning of treatment, so that 80 min later they lost their effectiveness. It seems probable, therefore that the main action of the calcium-activated barium sulfate consisted in preventing the intestinal absorption of ^{85}Sr, while the excretion of absorbed ^{85}Sr from blood to the gut was hardly influenced to any greater extent. (P.C.H.)

17467 ISOTOPE DISCRIMINATION EFFECTS IN THE METABOLISM OF TRITIATED GLUCOSE. Joseph Katz, Robert Rognstad, and Robert G. Kemp (Inst. for Medical Research, Cedars-Sinai Medical Center, Los Angeles). J. Biol. Chem., 240: PC1484-6(Mar. 1965).

For studies on isotope discrimination effects in the metabolism of tritiated-glucose, epididymal fat pad slices of fasted-refed rats were incubated in triplicate with glucose-1-T-1-^{14}C, glucose-6-T-6-^{14}C, and uniformly labeled glucose-3-T-^{14}C. The results showed that no tritium from glucose-3-T appeared in lactate or in the β carbon of glycerol; tritium yields from glucose-3-T in fatty acids exceeded those from glucose-1-T; and the $^{3}H:^{14}C$ ratio in glycerol from glucose-1-T-1-^{14}C definitely exceeded 1. The lack of tritium incorporation into lactate and the β position of glycerol indicates that tritium from position 3 of glucose is not transferred to DPNH and that TPNH does not exchange its hydrogen with DPNH. It was concluded that the incorporation of tritium from glucose-3-T into fatty acid (35%) could only occur via TPNH, arising during oxidation to ribulose-5-P and this incorporation was twice that from glucose-1-T. Thus hydrogen transfer to fatty acids via TPNH is very efficient. It was not proved however, that there is sufficient pentose cycle activity in adipose tissue to provide the total reductive capacity required for fatty acid synthesis. (P.C.H.)

17468 STRONTIUM–CALCIUM TRANSPORT ACROSS THE GILL OF RAINBOW TROUT, (SALMO GAIRDNERII). R. H. Schiffman (General Electric Co., Richland, Wash.). J. Cellular Comp. Physiol., 65: 1-5(Feb. 1965).

Experiments were performed using radioactive isotopes of calcium and strontium as tracers in a perfused gill preparation. There were two levels in the uptake rates for strontium and calcium: a passive rate of 0.5×10^{-7} cm/sec, and 1.8×10^{-7} cm/sec, respectively, and a tenfold higher energy dependent rate of 5.1×10^{-7} cm/sec for strontium and 17×10^{-7} cm/sec for calcium. There was no evidence of discriminatory interaction between calcium and stron-

tium at the passive levels of transport. Strontium was found to substitute for calcium at the active transport levels only if the calcium concentration of the environmental water was below approximately 0.1 mM Ca^{2+}/1. The rate of calcium and strontium loss from the gill was estimated as about 20 times faster than the influx rates. This caused the postulation that the net transfer of calcium ions across the gill could change, dependent upon the degree of saturation of the calcium-binding sites within the fish. (auth)

17469 UPTAKE AND RETENTION OF CESIUM 137 AND ZINC 65 BY SEAWEEDS. John Gutknecht (Univ. of North Carolina, Chapel Hill and Bureau of Commercial Fisheries Radiobiological Lab., Beaufort, N. C.). Limnol. Oceanog., 10: 58-66(Jan. 1965).

Uptake and retention of ^{137}Cs and ^{65}Zn by seaweeds was observed under various environmental conditions. Concentration factors and biological half lives varied widely among species, ^{65}Zn showing generally higher levels of uptake and retention. No significant relationship between growth rate and either concentration factor or biological half life was found among the species tested. Both uptake and loss of ^{137}Cs were stimulated by light, but some ^{137}Cs movements occurred in the dark. Both exogenous substrate (glutamate) and previous exposure to light stimulated ^{137}Cs uptake in the dark. Exposure to nitrogen in the dark inhibited both influx and efflux of ^{137}Cs. Neither darkness nor anoxia caused appreciable net loss of absorbed ^{137}Cs. ^{137}Cs was not extensively adsorbed by cell walls or killed tissue. Influx and efflux of Cs were proportional, respectively, to the external and internal Cs concentrations. Intracellular Cs appears to be largely ionic, with Cs movements being closely related to metabolism. ^{65}Zn was highly concentrated by living and killed algae and by cell walls. Light had a variable effect on ^{65}Zn movements. Zinc uptake at different external Zn concentrations agreed with the Freundlich adsorption equation. Adsorption exchange appears to be an important mechanism of Zn movements in seaweeds. (auth)

17470 DISEASES OF BONES AND JOINTS ASSOCIATED WITH INTOXICATION BY RADIOACTIVE SUBSTANCES, PRINCIPALLY RADIUM. Robert J. Hasterlik (Univ. of Chicago) and Asher J. Finkel. Med. Clin. N. Am., 49: 285-96(Jan. 1965).

Bone and joint changes related to the presence of significant quantities of ^{226}Ra in the skeleton are discussed. These include: coarsening of trabeculation, multiple large and small areas of resorption, especially in the cortices of long bones, spotty areas of sclerosis, aseptic necrosis and pathological fractures. The occurrence of the excessively rare epithelial or mesothelial tumor of the mastoids, or paranasal sinuses, or of the mucosa surrounding the tooth sockets should also suggest the presence of radium poisoning. Osteosarcomas in the older adult will in many instances be related to a previous iatrogenic or industrial exposure to radium, which may have taken place 30 or more years ago. (P.C.H.)

17471 THE DISTRIBUTION AND EXCRETION OF Y^{91} AND Ce^{144} FROM THE ORGANISM OF RATS. N. O. Razumovskii and O. L. Torchinskaya. Med. Radiol., 10: No. 1, 24-7(Jan. 1965). (In Russian)

The natural excretion of ^{91}Y and ^{144}Ce from the organism of rats was studied for $2\frac{1}{2}-4$ months after a single intraperitoneal injection of the isotope. It was found that ^{91}Y accumulates mainly in the bones, ^{144}Ce in the liver. The excretion of ^{91}Y and ^{144}Ce from the liver, spleen, and kidneys occurs quite intensively, whereby from the bones these radioactive elements are practically not excreted. In the excretion from the liver, spleen, and kidneys, two periods are distinguished. The first period consists of intensive excretion for 12-17 days after injection, and the second period exhibits slow excretion. This apparently is due to the fact that several types of bonds occur between isotopes and tissue substrates of even one organ. (auth)

17472 THE KINETICS OF Nb^{95} EXCRETION FROM THE RAT ORGANISM. (EXPERIMENTAL RESEARCH). Yu. I. Moskalev, G. V. Obvintsev, and V. S. Grinev. Med. Radiol., 10: No. 1, 28-9(Jan. 1965). (In Russian)

Studies were made on the kinetics of ^{95}Nb excretion from rats after intraperitoneal administration in a dose ranging from 3.3 to 160 μC per rat. The effective half life of ^{95}Nb amounted to 18.5 days. It did not depend on the quantity of the isotope introduced and the animal's sex. (auth)

17473 THE TOXICOLOGY OF RADIOSULFUR. N. M. Eganesyan (Dept. of Radiobiology, Academy of Sciences, Armanian SSR). Med. Radiol., 10: No. 1, 39-42(Jan. 1965). (In Russian)

Experiments were conducted on mice and rats. It was established that ^{35}S is endowed with a relatively low toxicity: the minimum lethal dose for mice is 15 mC/kg, for rats — 20 mC/kg, $LD_{50/30}$ for mice — 29 mC/kg, for rats — 31 mC/kg. LD_{100} for mice — 40 mC/kg, for rats — 45 mC/kg. In the organism of animals radiosulfur causes characteristic early changes of the blood which could be revealed by means of fluorescence microscopy. Morphological studies of the blood disclosed definite alterations of the red and white blood — reticulopenia, a left shift, eosinophilia, thrombocytopenia. Data are tabulated. (auth)

17474 THE HISTAMINE CONTENT AND HISTAMINASE ACTIVITY IN THE BLOOD IN CHRONIC STRONTIUM^{90} INTOXICATION. A. V. Fedorova. Med. Radiol., 10: No. 1, 43-5(Jan. 1965). (In Russian)

Studies were made of the histamine content and histaminase activity in the blood of rats receiving daily for a period of two years different concentrations of strontium-90. In animals receiving $8 \cdot 10^{-3}$ μC of ^{90}Sr, a 60% increase of histamine in the blood was found when the dose accumulation amounted to 25 Rem (60th day). There was a twofold increase of the histamine level when the average dose accumulation reached 119 Rem. However, in animals receiving $2 \cdot 10^{-4}$ microcurie of the isotope, after initial shifts on the 270-360 days, toward the end of observations the reaction normalized. In remote periods of action of ^{90}Sr in a concentration of $8 \cdot 10^{-3}$ microcurie studies of the enzymatic activity of histamine disclosed an initial rise with a subsequent insignificant decrease. In animals receiving ^{90}Sr in a concentration of $2 \cdot 10^{-4}$ microcurie the histaminase activity remained augmented both at initial and remote periods. (auth)

17475 THE USE OF PENTACINIUM FOR THE REMOVAL OF Pu^{239} FROM THE ORGANS OF RATS IN INHALATION AFFECTION. E. R. Lyubchanskii. Med. Radiol., 10: No. 1, 45-9(Jan. 1965). (In Russian)

In experiments on albino rats it is shown that in a single prophylactic inhalation of pentacinium (1.8 mg) performed 30 minutes before plutonium administration, the content of the latter in the lungs, skeleton, and liver is 12.1; 5.5 and 6.5 times lower than in the controls. In pentacinium inhalation 5 minutes and 1 and 4 hours after plutonium inhalation, the content of the latter in the above-mentioned organs is 4.5-6.0, 1.9-2.8, 3.8-5.5 times whereas in inhalation 24 hours later-1.5-2.3 times lower than in the nontreated animals. The use of insignificant quantities of pentacinium (1.8 and 3.6 mg) 40 days after plutonium inhalation proved to be ineffective. In contradistinction to inhalation, intravenous administration of 2.5 mg of pentacinium 30 minutes before plutonium inhalation exerted no influence on the isotope content in the lungs and skeleton of treated animals. (auth)

17476 A COMPARISON OF ^{3}H- AND ^{14}C-GLUCOSE METABOLISM IN THE INTACT RAT. Arnold Dunn and Susan Strahs (Univ. of Southern California, Los Angeles). Nature, 205: 705-6(Feb. 13, 1965).

Experiments were performed in order to ascertain whether or not glucose-6-^{3}H represents the entire glucose molecule. A mixture containing D-glucose-U-^{14}C and D-glucose-6-^{3}H was administered intra-arterially to unanaesthetized rats in a post-absorptive state. Serial samples of venous blood were taken at intervals between 30 and 130 min after isotope administration and specific activities of the plasma glucose with respect to both ^{14}C and ^{3}H were

determined. The results showed that ^{3}H: carbon-14 isotope ratio did not remain constant but decreased with time, indicating that the tritium was lost more rapidly than the ^{14}C. It was concluded that glucose-6-^{3}H cannot be used as a quantitative tracer for the glucose carbon chain in the intact rat. However, the loss of tritium observed may reflect an important physiological event in glucose metabolism in the intact organism. (P.C.H.)

17477 QUANTITATIVE CEREBRAL BLOOD FLOW DETERMINATION; APPLICATION OF A KRYPTON 85 DESATURATION TECHNIQUE IN MAN. L. C. McHenry, Jr. (Walter Reed Army Inst. of Research, Washington, D. C.). Neurology, 114: 785-93(1964).

A krypton-85 desaturation method, based on the Fick principle, was developed for the quantitative determination of cerebral blood flow. This is essentially a modification of the inert gas method. Cerebral blood flow values obtained by this method were similar to those reported by others for krypton-79 and nitrous oxide desaturation. The quantitative accuracy of the desaturation method will primarily depend on the length of time of saturation prior to the desaturation study. Ten minutes of saturation in normal individuals is most likely adequate. In patients anticipated to have diminished cerebral circulation, saturation should at least be extended to fifteen minutes and often to twenty-five minutes. (Excerpta Med., Sect. XXIII, 2: No. 2 (Feb. 1965))

17478 SODIUM- AND POTASSIUM-ACTIVATED ATPase IN UPTAKE OF Fe^{59} BY THE RABBIT RETICULOCYTE. W. C. Wise and J. W. Archdeacon (Univ. of Kentucky, Lexington). Proc. Soc. Exptl. Biol. Med., 118: 653-4(Mar. 1965).

Uptake of ^{59}Fe by rabbit reticulocytes in the presence of ouabain was inhibited. From such evidence it was concluded that the Na–K ATPase system is probably involved to some degree in iron transport in rabbit reticulocytes. (auth)

17479 SECRETION OF Sr^{85} AND Ca^{47} IN HUMAN SALIVA. Joseph Samachson, Vernice Vankinscott, and Herta Spencer (Veterans Administration Hospital, Hines, Ill.). Proc. Soc. Exptl. Biol. Med., 118: 747-51(Mar. 1965).

In a study of secretion of ^{85}Sr and of ^{47}Ca in saliva, the ratio of saliva concentration to plasma concentration varied from $\frac{1}{8}$ to $\frac{1}{3}$ for ^{85}Sr and from 2/5 to almost unity for ^{47}Ca. The average ratios favored secretion of ^{47}Ca by a factor of more than 2, the difference in secretion of the 2 isotopes being highly significant. Values for ^{47}Ca were in accord with the levels of stable calcium found in saliva. No difference in $^{85}Sr/^{47}Ca$ ratios of saliva in relation to plasma was found between patients on low and on high Ca intake. The high degree of discrimination of the salivary glands against the secretion of ^{85}Sr contrasts with the action of the kidneys in favoring secretion of ^{85}Sr over that of radiocalcium by a factor of approximately 3 to 1. (auth)

17480 METABOLISM OF ZINC-65 IN MAN. Herta Spencer (Veterans Administration Hospital, Hines, Ill.), Betty Rosoff, Arthur Feldstein, Stanton H. Cohn, and Ernest Gusmano. Radiation Res., 24: 432-45(Mar. 1965).

The plasma levels, excretions, whole-body retention, and tissue distribution of ^{65}Zn were determined in man after a single intravenous injection of ^{65}Zn as the chloride. The level of ^{65}Zn in plasma decreased rapidly with time, while the concentration of ^{65}Zn in whole blood remained high. The ratio of ^{65}Zn in whole blood to that of plasma was 3:1 at 24 hours and increased in the subsequent four weeks. The main pathway of ^{65}Zn excretion was via the intestine. The whole-body retention of ^{65}Zn determined in two patients with the whole-body counter could be described by the sum of two exponential functions. The average biological half life of the smaller compartment was 12.5 days, and the turnover rate of the larger compartment averaged 322 days. Tissue distribution studies revealed that the uptake of ^{65}Zn was highest in liver, kidney, and spleen and that these concentrations decreased with time. The uptake of ^{65}Zn in tissues of glandular organs, including the pancreas and prostate, was relatively high, but the uptake in these organs was lower than in liver and kidney. Distinct differences in ^{65}Zn uptake were observed in different types of skeletal muscle. The ^{65}Zn concentration in large and small intestine was also relatively high. (auth)

17481 MUTAGENIC AND ANTIMUTAGENIC ACTION OF RADIOPROTECTORS. N. P. Duvinin and V. K. Shcherbakov. Radiobiologiya, 4: 862-4(1964). (In Russian)

Data on the percentage of anaphasic changes are presented which show the antimutagenic effect of cystiamine in horse beans. Cysteine hydrochloride of 1% concentration stopped mitosis in onion seedlings but 0.1% doubled the anaphasic changes and 0.01 and 0.001% had little inhibiting effect. Arginine at 2 and 20 mg/ml doubled and tripled, respectively, the percentage of mutations in cells of Ehrlich ascites carcinomas and at 0.2 mg/ml increased the frequency somewhat in onion cells. (IIC-M.G.)

17482 COMPARATIVE EFFECTIVENESS OF SOME SUBSTANCES INDUCING FORMATION OF COMPLEXES IN THE SPEEDING OF ^{65}Zn EXCRETION FROM THE ORGANISM. L. A. Il'in, G. V. Arhangelskaya, and T. A. Norets. Radiobiologiya, 4: 926-7(1964). (In Russian)

DTPA caused rapid removal of ^{65}Zn from the organs of adult male white rats while unithiol had no effect on ^{65}Zn metabolism. (tr-auth)

17483 ACCUMULATION OF ^{90}Sr, ^{90}Y, ^{144}Ce, ^{106}Ru, ^{59}Fe AND ^{35}S IN MELANOGRAMMUS AEGLEFINUS DEVELOPING SPAWN. V. N. Ivanov (Kovalevskii Inst. of Biology of Southern Seas, Sevastopol, USSR). Radiobiologiya, 5: 57-60(1965). (In Russian)

Data are presented that show the ability of pelagic spawn of Black Sea fish to accumulate ^{90}Sr, ^{90}Y, ^{144}Ce, ^{106}Ru, ^{59}Fe, and ^{35}S or their daughter products, with the exception of ^{35}S. (tr-auth)

17484 REMOVAL OF RADIOACTIVE MONAZITE DUST FROM THE LUNGS OF RATS AFTER INTRATRACHEAL ADMINISTRATION. B. F. Thiart and F. M. Engelbrecht (Univ. of Stellenbosch, South Africa). S. African Med. J., 38: 542-4(1964).

Male rats were injected intratracheally with radioactive monazite dust (50 mg./rat). Animals were killed at regular intervals, and the degree of radioactivy of the lungs, hilar lymph nodes, spleen, and liver was determined separately in a scintillation counter. The histology of the lungs and hilar lymph nodes was followed-up for 278 days. By means of an intratracheal method it is possible to ensure that nearly the whole dose of dust suspension is deposited in the alveoli and alveolar ducts. The removal of radioactive monazite dust from the alveoli is a slow and continuous process. During the first few weeks after injection the rate of elimination reached a maximum, thereafter it became increasingly slower. Elimination of dust particles is effected mainly via the bronchial tree and the lymphatic system; removal via the lymphatic vessels occurs only to a very minor extent as compared to the amount of dust excreted via the trachea. The rate of dust elimination from the alveoli varied quite considerably among the individual rats. Judged by the degree of radioactivity and the histological appearance of the hilar lymph nodes it would appear that the amount of dust removed via the lymphatic system also differed from animal to animal. No indication of radioactive material could be detected in the liver and spleen of the animals. (Excerpta Med., Sect. XXIII, 2: No. 2(Feb. 1965))

17485 RADIOTRACER METHODOLOGY IN BIOLOGICAL SCIENCE. C. H. Wang and David L. Willis. Prentice-Hall Biological Science Series. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1965. 398p. $12.00.

After a brief introduction on the development of tracer techniques in biology, information is included on: principles of radiotracer methodology, including atoms and nuclides; the nature of radioactive decay; characteristics of ionizing radiation; measurement of radioactivity by gas ionization,

solid (external-sample) scintillation, and liquid (internal-sample) scintillation; detection of radioactivity by autoradiography; preparation of counting samples; analysis of data in radioactivity measurements; design and execution of radiotracer experiments; availability of radioisotope-labeled compounds; safe handling of radioisotopes; and design features of radiotracer laboratories; basic experiments in the measurement of radioactivity, including the operation and characteristics of a Geiger-Mueller counter, proportional counter, and solid and liquid scintillation counters; nature of radioactive decay; interaction of radiation with matter; and statistical considerations in the measurement of radioactivity; and illustrative radiotracer experiments, including the use of ^{14}C, ^{59}Fe, ^{22}Na, and ^{65}Zn. (P.C.H.)

17486 THE INFLUENCE OF VITAMINS D_3 AND A_1 ON THE Sr^{90} METABOLISM OF GROWING RATS. B. Schmidt. Thesis, Mainz, Universitat, 1964. 132p. $2.00(Gmelin, AED-DISS. 64-208). (In German)

Resorption of Ca and ^{90}Sr is increased by vitamins A and D, but very high vitamin doses inhibit Ca and Sr uptake. Effects of vitamins on skeleton retention and kidney excretion of Ca and Sr are investigated. It is concluded that vitamin D is not recommendable after ^{90}Sr uptake. Small doses of vitamin A increase the blood clearance through the kidneys. (Gmelin Inst.)

17487 ANTIPYRINE DISTRIBUTION VOLUME AND TOTAL K (K^{40} ACTIVITY) OF 35 MALE PATIENTS WITH NORMAL METABOLISM. M. Buech. Thesis, Saarland, Ger., Universitat, 1964. $2.00(Gmelin, AED-DISS. 64-203). (In German)

Methods for the measurement of total body water are discussed. Body water and total K of 35 persons were measured using the antipyrine method and whole body counting of ^{40}K activity, respectively. Significant linear correlations were found between total K, body weight, and water content. (Gmelin Inst.)

17488 STUDIES OF THE QUANTITATIVE DETERMINATION OF THE METABOLISM OF RADIOACTIVE P IN ORGAN EXPLANTATIONS. P. Doerr. Thesis, Munich, Universitat, 1963. 39p. $2.00(Gmelin, AED-DISS. 63-723). (In German)

Phosphorus-32 uptake of organ explantations is proportional to the square root of explantation weight in the range of 1 to 3 mg. Dependence of ^{32}P uptake on O_2 partial pressure is given. (Gmelin Inst.)

17489 STUDIES OF THE DEPENDENCE OF THE RESORPTION OF AN INTRAMUSCULAR I^{131} DEPOSIT ON BLOOD VOLUME. G. Gruener. Thesis, Munich, Universitat, 1963. 58p. $2.00(Gmelin, AED-DISS. 63-722). (In German)

A combination method for the recording of blood volume and resorption rate of an intramuscular ^{131}I deposit in the lower limb using a mercury-in-rubber strain gage method and a scintillation counter is described. A linear relation between resorption rate and blood current was observed. During hyperaemia produced by work, blood volume decreases more slowly than the resorption rate. (Gmelin Inst.)

Radiation Effects

17490 (CEA-Big-20) MODIFICATIONS DES ACTIVITES ELECTRIQUES SPONTANEES ET EVOQUEES DE L'ENCEPHALE EN LIAISON AVEC L'ACTION DES RAYONNEMENTS IONISANTS. (Modifications of the Spontaneous and Evoked Electric Activities of the Encephalon Linked with the Action of Ionizing Radiations). Lucie Roule (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Nov. 1964. 19p. Dep.(mn).

Recent research establishes that small doses of ionizing radiation modify the electrical activity of the brain, whether spontaneous or evoked. Experimentation on cats, dogs, and rats indicates that even very small x radiation doses, 0.1R to 0.2R, produce a desynchronisation reaction. Larger doses, nearing DL 50, i.e. 400 rads, also cause changes in spontaneous and evoked activity of various brain structures. (auth)

17491 (ORNL-P-802) CALCULATED TISSUE CURRENT-TO-DOSE CONVERSION FACTORS FOR NUCLEONS OF ENERGY BELOW 400 Mev. W. E. Kinney (Oak Ridge National Lab., Tenn.) and C. D. Zerby (Union Carbide Research Inst., Tarrytown, N. Y.). [1964]. Contract [W-7405-eng-26]. 36p. (CONF-720-22). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

A useful and simple way of estimating the biological effects of high-energy radiation in space or near accelerators is to multiply the current of a given type of incident particle by the appropriate current-to-dose conversion factor to obtain a measure of the dose received. The physiological effects of radiation can be determined only by experiment, but in the past these effects have been correlated with the dose in the case of low-energy radiation and it is expected that the same situation will prevail at high energy, although the correlation may be more complicated. To facilitate possible correlations, a series of Monte Carlo calculations were carried out to determine many details about the energy deposition in tissue as a function of depth. From these data rad (1 rad = 100 ergs/g) and rem (roentgen equivalent man) doses were calculated and current-to-dose conversion factors for the surface and 5-cm-depth doses and for the average whole-body and peak doses were extracted for hazard evaluation. Both incident neutrons and protons from 60- to 400-Mev incident energy were considered. The most striking feature of this calculation is the significant contribution that the heavy recoils make to the rem dose for case of incident neutrons or protons. In the case of incident protons the contribution is in general of the order of 10 to 20% but for incident neutrons it constitutes the greatest fraction of the total contribution. Unfortunately the rad dose from the heavy particles was converted to rem dose by using a QF from the high LET and results point up the necessity of establishing the QF's with some degree of accuracy for high LET values if any reasonable degree of accuracy is to be expected in the current-to-rem dose conversion factors. As a consequence of the significant contribution of the heavy particles and secondary protons to the rem dose, it is not reasonable to expect that the rem dose at any depth from incident protons can be calculated very accurately unless the secondary radiation created in the body is taken into consideration. For the case of incident neutrons this is obviously true because only through secondary radiations is it possible for neutrons to deposit energy. (C.H.)

17492 (TID-21493) EFFECTS OF IONIZING RADIATIONS ON THE CONTROL MECHANISMS OF LIPID TRANSPORT. Annual Report No. 1, November 1, 1962–October 31, 1963. (Milan Univ. (Italy). Istituto di Farmacologia e di Terapia). Contract AT(30-1)-3097. 21p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Total-body x irradiation induced increase of plasma cholesterol and triglyceride level with ample variations in different species. In rabbits this effect on lipid transport was particularly evident. The possible mechanisms of radiation induced hyperlipemia in rabbits were analyzed. No increase in free fatty acid release or in fatty acid synthesis in the liver was observed before the induction of hyperlipemia. The pronounced increase of incorporation of labeled precursors in liver, but not in brain, cholesterol and fatty acids represents a reaction against a reduced uptake of plasma lipids by the liver. (auth)

17493 (TID-21496) EFFECTS OF IONIZING RADIATIONS ON THE CONTROL MECHANISMS OF LIPID TRANSPORT. Annual Report No. 2, February 1, 1964–January 31, 1965. (Milan Univ. (Italy). Istituto di Farmacologia e di Terapia). Contract AT(30-1)-3097. 24p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Total body x irradiation (1000R) induced a significant increase in cholesterol and triglyceride plasma levels of old rats and a much more pronounced effect on the same

lipid fractions in rabbits. The three possible mechanisms responsible for this type of hyperlipemia were investigated. Increased lipid mobilization, fatty acid synthesis in the liver or triglyceride hypersecretion to the plasma could not be invoked as the responsible mechanisms. Data indicate a decreased peripheral utilization of triglycerides as the major cause of hyperlipemia. The modified lipoproteins produced in irradiated rabbits and accumulated in the plasma compartment were slowly metabolized by the RES and the resulting hyperlipemia is therefore greatly dependent on the functional activity of RES. A conventional radioprotective drug (cysteamine) was not able to counteract this particular effect of total-body irradiation. (auth)

17494 (FTD-TT-64-1316(p.205-16)) COMBINED EFFECT OF LOW-FREQUENCY VIBRATION AND X-RAYS ON MAMMALIAN BONE-MARROW CELLS. Yu. S. Demin. Translated from Kosmich. Issled., 2: 939-45(1964).

White mice were subjected to the individual and combined action of vibration and ionizing radiation to determine how these factors affect the cytogenetics of bone marrow. In all, 161 male mice were used, 18 of which served as controls. The animals received 50-R doses of x rays 3–5 minutes after being subjected to vertical vibration (70 cps; 0.4-mm amplitude; 20-min duration). Experimental animals were divided into 3 groups which received vibration only; received x irradiation only; received both vibration and irradiation. Each of these groups had biological controls. Decapitation was accomplished ½, 1, 2½, 5, 7, 10, 15, 18, 24, 28, 32, 36, 42, and 48 hr after exposure to the experimental parameters. Femoral and tibial marrow was prepared at 0°C and stained with acetocarmine. Mitotic disruption was studied at anaphase and early and mid telophase. A detailed statistical analysis of the results revealed that vibration alone increased the frequency of mitotic disruption characterized by increased chromosomal adhesion. Vibration prior to irradiation did not increase the number of mitotic disruptions, but it decreased the number of chromosomal rearrangements and increased the number of chromosomal adhesions. In general, it was concluded that combined vibration and irradiation did not increase the frequency of mitotic disruption any more than did irradiation alone; thus, it is felt that the vibration frequency may have been too low to produce a significant effect. It is felt that the mechanism by which vibration produces mitotic changes in the cell is imperfectly known and requires further study. (ATD)

17495 (JPRS-28405) RADIATION EFFECTS ON PLANTS AND GRAVITY EFFECTS ON THE ANIMAL ORGANISM. Translated from Izv. Akad. Nauk SSSR, Ser. Biol., No. 6, 827-50; 852-60; 913-15(Nov.-Dec. 1964). 50p. (TT-65-30180). $3.00(CFSTI).

For an abstract of the individual paper see: 17496.

17496 (JPRS-28405(p.1-32)) CYTOPHYSIOLOGICAL AND BIOCHEMICAL INVESTIGATIONS OF MICROORGANISMS DURING THEIR RESTORATION FOLLOWING RADIATION INJURY. M. N. Meysel', et al. Translated from Izv. Akad. Nauk SSSR, Ser. Biol., No. 6, 827-50(Nov.-Dec. 1964).

Results are reported from physiological and biochemical investigations of restoration in microorganisms following radiation injury. Data are reported from studies in several strains of yeast representative of the genera Saccharomyces, Saccharomycodes, Schizosaccharomyces, Endomyces, Candida, and Torulopsis. Emphasis was placed on studies of Saccharomyces vini. It was concluded that processes involved in radiation inactivation and reactivation in yeast are highly involved and include not only damage and restoration of genetic structures but structures of the cytoplasm and other nuclear elements that are involved in cellular metabolism. A review of the literature on restoration of radiation injuries at the cellular and sub-cellular level is included. (C.H.)

17497 (JPRS-28780(p.24-8)) ON THE POSSIBILITY OF CLINICAL RECOVERY FROM ACUTE RADIATION SICKNESS. A. V. Barabanova and A. K. Gus'kova. Translated from Klinich. Mec., 42: 137-9(Nov. 1964).

The clinical picture of a patient exposed to approximately 300 Rem external γ and neutron irradiation, resulting in radiation sickness of medium severity, is reviewed 10 years after the exposure. The data indicate a state of clinical recovery. (C.H.)

17498 STUDIES ON INTESTINAL ABSORPTION CHANGES, WITH I^{131}-TRIOLEIN IN WHOLE-BODY X-RAYED RATS. G. E. Slaviero, G. Cultrera, W. R. Zanolla, and A. Schifino (Universita, Pavia, Italy). Acta Isotopica, 4: 67-79(1964). (In Italian)

Intestinal absorption changes in whole-body x irradiated rats were investigated using ^{131}I-triolein. Studies were carried out with 500 and 1000 R, 1 day and 7 days after irradiation. The data suggest that after 24 hours the gastric retention is increased and the intestinal absorption depressed. The data collected after 7 days are not conclusive. (auth)

17499 THE RADIATION SENSITIVITY OF ESCHERICHIA COLI CULTURES. I. PHYSIOLOGICAL FACTORS HAVING INFLUENCE ON RADIATION SENSITIVITY. Ferenc Hernadi, Gyorgy Csoban, and Zsolt Nagy (Medical Univ. of Debrecen, Hungary). Acta Microbiol. Acad. Sci. Hung., 11: 99-103(1964).

Changes in the radiosensitivity of E. coli B cultures during their growth cycle were investigated. It was established that their radiosensitivity varies during the culture period. The greatest variations were observed in the log phase, known to be kinetically constant. A relation was demonstrated between the variations in radiosensitivity and the electrode potential in the culture. On this basis the most radiosensitive condition of the culture was estimated from the electrode potential curve. Theoretical and practical inferences were drawn from these results. (CFSTI)

17500 THE INFLUENCE OF OCCUPATIONAL EXPOSURE TO RADIATION ON THE MORTALITY OF AMERICAN RADIOLOGISTS AND OTHER MEDICAL SPECIALISTS. Raymond Seltser and Philip E. Sartwell (Johns Hopkins Univ., Baltimore). Am. J. Epidemiol., 81: 2-22(Jan. 1965).

Attempts were made to determine whether the mortality of radiologists and other physician specialists who use x rays exceeds that of specialists who do not; and if so, what causes of death are responsible for the excess mortality. Mortality data of members of five American medical specialty societies were studied over the period 1935 through 1958 to test the hypothesis that mortality is increased by occupational exposure to ionizing radiation. The societies selected were ones with a postulated gradient of radiation exposures (high, intermediate, and low). Mortality rates conformed in detail to the hypothesis. The median age at death, estimated by life-table methods for the first time interval studied, was five years greater for the lowest-exposure than the highest-exposure society. Comparison of matched and paired subjects from the low-exposure and high-exposure societies confirmed this finding. The differences in mortality increased with age, but have decreased with calendar time for all except the oldest age classes. There was no excess mortality among radiologists in the age class 35 through 49 years over the period 1945 through 1958, suggesting that the radiation hazard may have been controlled. The increased mortality risk was distributed over a number of assigned causes of death. Mortality from cancer, cardiovascular-renal disease, and all other causes combined were increased in the societies with high exposure. Leukemia, as expected from previous studies, showed the highest mortality ratio (ratio of observed to expected deaths) at the combined ages, followed by all other causes, all other cancer, and cardiovascular disease. In general (with the exception of leukemia and other cancer) the ratios were highest in the oldest age groups. The leukemia excess, and to a lesser extent the excess in other cancers combined, was greatest during the latest working years and the excess in other causes during the largely post-retirement years. These findings indicate that occupational exposure to ion-

izing radiation produced an unfavorable effect on survivorship of radiologists which may be similar to the life-shortening effect which has been previously described in populations of experimental animals. (BBB)

17501 MICROCIRCULATORY EFFECTS OF WHOLE-BODY X-IRRADIATION AND RADIOMIMETIC PROCEDURES. Benjamin W. Zweifach and Evelyn Kivy-Rosenberg (New York Univ., New York). Am. J. Physiol., 208: 492-8 (Mar. 1965).

Whole-body x irradiation (WBR) was administered to young adult, unanesthetized rats. Terminal vascular beds of the exteriorized mesocecum of these rats (most of which had received relatively high doses of x rays) were observed (under anesthesia) at selected periods between 1 hr and 48 days postirradiation. Thirteen experimental categories were utilized to determine the status of reactivity and of the microvascular barrier. These included topical application of epinephrine, norepinephrine, histamine, and Versene; and injection of heparin, cortisone, nitrogen mustard, bacterial endotoxin, and carbon. Results indicate that by the 3rd–4th day after WBR, response of terminal arterioles and precapillaries to epinephrine and norepinephrine are exaggerated and by the 2nd week, activity is up tenfold over threshold levels. With regard to venular and capillary walls, Versene had a dramatic disruptive effect. The character of the lesion suggests that it is due to an undermining and weakening of the basement membrane, and/or forces which hold the endothelial cells together. There is no evidence, however, that the endothelial cell has been damaged. (auth)

17502 THE CENTRAL NERVOUS SYSTEM IN LEUKEMIA. John P. Phair, Robert E. Anderson, and Hideo Namiki (Atomic Bomb Casualty Commission, Hiroshima). Ann. Internal Med., 61: 863-75(Nov. 1964). (TID-21180)

Clinical and pathologic findings in 165 cases of leukemia autopsied during the period 1949 to 1962 at Atomic Bomb Casualty Committee in Hiroshima and Nagasaki, Japan, are summarized. Significant parenchymal hemorrhage occurred most often in acute myelogenous leukemia and was markedly increased in patients dying with high terminal white blood cell counts. Possible mechanisms involved in the pathogenesis of cerebral hemorrhage in leukemia are discussed. Subarachnoid hemorrhage and subdural hematoma were not related to leukocytosis but appeared to be influenced by marked thrombocytopenia. Leukemic infiltrates of a diffuse nature involving the meninges were paradoxically increased in patients receiving adequate chemotherapy; meningeal tumors did not show this peculiar relationship to therapy. Infections involving the central nervous system were confined to patients receiving chemotherapy including steroids. (auth)

17503 THE ROLE OF THE THYMUS IN RESTORING IMMUNOLOGICAL REACTIVITY AND LYMPHOID CELL DIFFERENTIATION IN X-IRRADIATED ADULT MICE. Michael Feldman and Amiela Globerson (Weizmann Inst. of Science, Rehovoth, Israel). Ann. N. Y. Acad. Sci., 120: 182-90(Nov. 30, 1964).

Results are reported from a series of experiments made to test the function of the thymus in restoring immunological reactivity of x irradiated mice to foreign tumor transplants. Data are presented on the effect of thymectomy followed by x irradiation on immune reactions, the effects of thymectomy and x irradiation on the number of lymphatic follicles in spleens, the effects of thymectomy and x irradiation on the proliferation of erythropoietic noduli in spleens, and the restoration of immunological reactivity of thymectomized radiation chimeras by thymus grafts. (C.H.)

17504 IMMUNOLOGIC ROLE OF THE THYMUS IN RADIATION CHIMERAS. J. F. A. P. Miller, Elizabeth Leuchars, A. Marjorie Cross, and Peter Dukor (Royal Cancer Hospital, London). Ann. N. Y. Acad. Sci., 120: 205-17(Nov. 30, 1964).

Mice of the CBA and C57BL strains were thymectomized at two months of age, subjected to a lethal dose of total-body x irradiation, and protected with marrow, fetal liver, or spleen cells from syngeneic adult donors. Thymectomized mice protected with marrow showed some trophic disturbances, such as loss of body weight between 30 and 70 days postirradiation, but thereafter recovered. Sham-thymectomized controls showed no such disturbances. The lymphocyte population of the blood and tissues of thymectomized, irradiated mice was diminished in contrast to that of controls. Sham-thymectomized, irradiated mice, protected with either marrow, fetal liver, or spleen cells, were capable of rejecting allogeneic skin grafts within 20 days when grafted four weeks after irradiation. Thymectomized, irradiated mice, however, protected with either fetal liver cells or with doses of up to 40 million marrow cells, never recovered the capacity to reject allogeneic skin grafts. Such mice, protected with spleen cells from normal adult donors, but not from donors thymectomized at birth, could reject skin grafts within normal periods of time. Implanting either syngeneic or allogeneic thymus tissue subcutaneously or under the renal capsule enabled thymectomized, irradiated mice to recover practically normal immune functions. Mice bearing allogeneic thymus implants rejected thymus-donor type skin as a second-set response and showed evidence of having rejected the thymus graft. Thymus tissue enclosed in cell-impenetrable diffusion chambers implanted into the peritoneal cavity of thymectomized, irradiated mice also enabled such mice to recover immune capacity. It is concluded that marrow cell suspensions lack adequate numbers of immunologically competent cells but contain precursor cells which mature to immunocompetent cells under the influence of a humoral thymus mechanism. (auth)

17505 ROLE OF THE THYMUS IN THE RADIATION CHIMERA. D. W. H. Barnes, J. F. Loutit, and Janet M. Sansom (Medical Research Council, Harwell, Berks, Eng.). Ann. N. Y. Acad. Sci., 120: 218-24(Nov. 30, 1964).

CBA/H thymectomized adolescent mice, lethally x irradiated at two to three months and treated with syngeneic hemopoietic cell suspensions, may be subsequently less fit than comparably treated nonthymectomized mice. This is notable when the therapeutic suspension is of fetal liver cells. Failure of recovery of the irradiated animal's lymphatic system is then more pronounced and there is some delay in the shedding of C57BL skin grafts, although this is shorter than the delay described by others. However, supplementation of the hemopoietic cells with syngeneic cells from normal lymph nodes leads to an optimal result as in nonthymectomized CBA/H mice. (auth)

17506 STUDIES ON THE TOLERANCE OF THE IMMUNE SYSTEM OF MOUSE CHIMERAS. Gino Doria (Atomic Energy Commission, Casaccia, Italy). Ann. N. Y. Acad. Sci., 120: 225-9(Nov. 30, 1964).

An experimental analysis was made of the immune system of tolerant mice and radiation chimeras several months after the injection of homologous hemopoietic cells. An attempt was made to identify host and donor antibody-forming cells and to evaluate their functional state. (C.H.)

17507 THE ACTIVATION OF EXPERIMENTAL AND CLINICAL IMMUNOLOGIC DISEASES BY X-IRRADIATION AND ALKYLATING AGENTS. Robert S. Schwartz (Pratt Clinic-New England Center Hospital, Boston and Tufts Univ., Boston). Ann. N. Y. Acad. Sci., 123: 64-78(Mar. 12, 1965).

Two aspects of the paradoxical enhancement of immunologic disease by radiation and alkylating agents are discussed. In both the graft versus host reaction of inbred mice and chronic lymphocytic leukemia of man, these forms of treatment appear to act as triggers in the development of immunologic complications. The mechanism of the triggering action is unknown. An hypothesis that attempts to explain this and some other actions of radiation and chemotherapy on immunity is presented. (auth)

17508 QUANTITATION OF CELLULAR RADIOBIOLOGICAL RESPONSES. G. F. Whitmore and J. E. Till (Univ. of Toronto and Ontario Cancer Inst., Toronto). Ann. Rev. Nucl. Sci., 14: 347-74(1964).

A review is presented on experiments that determine the effect of radiation on cells of a single type, in most cases growing without complex interactions with cells of different types. A concept that may unify some of the observations and also make possible predictions concerning the postirradiation behavior of cell populations is presented. Some of the problems that arise in considering radiation effects on complex cell systems in vivo are also included. 124 references are included. (P.C.H.)

17509 HETEROCATALYTIC STATES OF ACTIVITY OF THE X CHROMOSOMES IN MAMMALS. Simone Bailly (Faculte des Sciences, Paris). Annee Biol., 4: 377-84 (1964). (In French)

Radiation effects on x chromosomes in mammals are reviewed. The results are discussed in relation to genetic effects based on changes in DNA and other chemical constituents. (P.C.H.)

17510 INFLUENCE OF TEMPERATURE ON ULTRAVIOLET INJURY. Robert G. Freeman and John M. Knox (Baylor Univ., Houston, Tex.). Arch. Dermatol., 89: 858-64(June 1964).

The influence of temperature on injury resulting from uv irradiation was investigated in young adult male and female albino mice. Elevation of skin temperature 10°F enhanced the injurious effect of uv exposure. This was shown in mice subjected to acute uv burns and in mice killed by continuous uv exposure. Irradiated mice living in a heated environment did not live as long as mice kept at room temperature. The rate of development of skin tumors was higher in mice exposed to uv light and kept in a hot environment than in mice exposed to uv light and kept at room temperature or heated for three hr after exposure. Fewer tumors appeared in mice heated for three hr before uv exposure. Uv wavelengths causing death were shorter than 3200 Å, including the erythemal and carcinogenic (2800 to 3200 Å) as well as the germicidal wavelengths in the 2537 Å band. All these wavelengths were included in the uv light which killed unshielded groups after only two days of exposure. Mice shielded from these wavelengths by window glass remained unharmed for the time of the experiment, indicating that the deadly wavelengths were shorter than 3200 Å. Pyrex glass transmitted some biologically active wavelengths as low as 2900 Å, and mice shielded by this material died after 20 days. This suggests that wavelengths between 2900 and 3200 Å were responsible for their death, although it does not rule out the possibility that shorter wavelengths also are deadly. (BBB)

17511 AN INVESTIGATION OF CELL DIVISION ACTIVITY IN AXOLOTL LARVAE AND LARVAE OF TRITON PUNCTATUS, AND ALSO EXPERIMENTS WITH IRRADIATION BY ULTRAVIOLET LIGHT AND CONSTANT ELECTRIC LIGHT. Thydsen Meinertz (Universitat, Copenhagen). Arch. Entwicklungsmech. Organ., 154: 513-25(1963). (In German)

Investigations on the normal cell division rhythm in larvae of Triton punctatus and Axolotl were carried out. The results of five series of experiments are tabulated. A research series was then begun with constant electric light and three series with electric light of 6 or 18 hrs and dark of 18 or 6 hours. The results showed only a blurring of the normal cell division rhythm and not as expected a difference in the mitotic activity in the light and dark periods. Two series were undertaken to determine the effects of ultraviolet light. The strongest effect was seen 2 hr after starting the experiment with definite decrease of the mitotic activity. In the study of the normal cell division rhythm, 4 maxima and 4 minima were detected in the course of 24 hrs. A certain regularity seemed to exist in the rhythm. The origin is not clear, but the minima found can have their background in the physical activity in the uptake of food. (tr-auth)

17512 EFFECT OF IONIZING IRRADIATION ON DIURESIS. Z. Wiktor, K. Jacyszyn, and J. Samsonowicz-Dec (Medical Academy, Wroclaw, Poland). Arch. Physik. Therapie, 16: 231-40(1964).

A study was made of the effects of ionizing rays (α-particles) on diuresis, by means of inhalation of radon for 1 hour (in Swieradów). A marked diuretic effect was noted. Radon inhalation exclusively led to excretion of water, which secondarily led to an increase of the sodium excretion index (UV_{Na}) and an increase in sodium clearance. There was a statistically significant increase in blood potassium. Further studies are necessary on the possible indirect effect of radiation on the erythrocytes. Parenteral use of radon is a suitable method for provoking diuresis, and it can be used in cases of cardiac or renal edema. (Excerpta Med., Sect. XXIII, 2: No.1 (Jan. 1965))

17513 THE EFFECT OF IRRADIATION ON LIFE-EXPECTANCY OF THE ERYTHROCYTES IN TUMOR-BEARING MICE. G. Von Hevesy, D. Lockner, and U. Eriksson (Universitet, Stockholm). Arzneimittel-Forsch., 14: 741-3(1964).

Irradiation of tumor-bearing mice with 550 Rad ^{60}Co irradiation did not influence the life-expectancy of their erythrocytes. Not after 150 Rad, but possibly after 550 Rad a fraction of the erythrocytes leave the circulation. Following irradiation with 550 Rad a smaller quantity of ^{14}C is incorporated into the circulating erythrocytes. 50,000 Rad were necessary to accelerate hemolysis of erythrocytes in vitro. The erythrocytes of tumor-bearing mice did not show specific sensitivity to irradiation. (Excerpta Med., Sect. XXIII, 2: No. 2(Feb. 1965))

17514 EFFECTS OF LOW-IRRADIATION DOSES ON LONGEVITY. Anta Dunjic. Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 9: No. 53, 3-5(Dec. 1964). (In French)

The principal experimental data on the effects of low irradiation doses on the longevity of laboratory animals are reviewed. The mechanisms and theories derived to explain longevity effects are summarized. The observations made on the few cases available on the effects of low radiation doses in man are discussed. (J.S.R.)

17515 LOCAL IRRADIATIONS. M. J.-R. Maisin. Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 9: No. 53, 7-10(Dec. 1964). (In French)

Some general data on the radiosensitivity of organs of mammals as a function of the age, the effects at a distance, and the utility of cytogenetics as a means of diagnosis are presented. Local irradiation of some systems or organs—especially the central and autonomous nervous system, the digestive system, eyes, thymus, the thyroid gland, and the cutaneous system—is discussed. The dangers of contamination by radionuclides are reviewed. (J.S.R.)

17516 THE EFFECTIVE RESIDUAL DOSE (E.R.D.): MEASUREMENT OF THE RADIOLOGICAL LESION IN MAMMALS. D. J. Mewissen. Assoc. Belge. Develop. Pacifique Energie At., Bull. Inform., 9: No. 53, 11-14(Dec. 1964). (In French)

The definition and method of calculating the effective residual dose are given. The use of the E.R.D. for the measurement of radiological lesions as long as it is expressed organically in acute effects is discussed. The specific case of the chronic irradiation of the higher mammals is considered, and the relation between the primary lesion and the dose in R per week in the burro is discussed. (J.S.R.)

17517 STRUCTURAL AND PHYSIOLOGICAL RELATIONSHIPS WITHIN THE TD LOCUS IN NEUROSPORA CRASSA. Ann M. Lacy (Goucher Coll., Baltimore). Biochem. Biophys. Res. Commun., 18: 812-23(Mar. 12, 1965).

Relations between td mutants in Neurospora crassa were investigated through biochemical, recombinational, and complementational analyses. Biochemical studies indicated that profound mutants do not lack all three enzymatic activities, but exhibit low activity for reaction 3f (indole glycerol phosphate → indole) in vitro. Recombination analyses indicated that the mutants considered are arranged in the same three major clusters observed in maps of other td mutants. Complementational analyses indicated that certain CRM^- mutants can complement. The analyses

also made it possible to reduce the number of NIU complementing groups from four to two, and to place the IU mutants into a third group. The only major discrepancy between the present complementation and the recombination maps is the clustering of CRM⁻ complementing mutants with the IA mutants on the complementation map and with the profound mutants on the recombination map. A possible basis for the relations observed between groups of td mutants is discussed. (P.C.H.)

17518 THE ABSENCE OF NUCLEAR CONTROL OVER THE INCREASE IN CATHEPSIN ACTIVITY DURING EARLY EMBRYOGENESIS. A. A. Neifakh and E. R. Davidov (Severtsov Inst. of Animal Morphology, Moscow). Biochemistry (USSR) (English Transl.), 29: 235-42(Mar.-Apr. 1964). Translated from Biokhimiya, 29: 273-82(Mar.-Apr. 1964).

The cathepsin activity (substrate–casein, pH 4.2) increases linearly during the development of fish embryos (groundling), and is seven times as great as the initial value at the end of embryonic development. The increase in the cathepsin activity during the early embryonic period is not controlled by the genetic apparatus of the embryo, since radiation inactivation of the nuclei, performed before fertilization or during development did not influence the rate of activation of this enzyme. Approximately one third of all the activity was related to the cells of the embryo, and two thirds to the yolk, but the specific activity of the cell was substantially higher. All or almost all (90%) of the cathepsin activity was related to the fraction that was not precipitated at 1200 g. The direct action of high doses of radiation (40 kR) on the cytoplasm led to a small inactivation of cathepsin (10-20%), but substantially decreased the rate of increase in its activity during development, almost to half its normal value. (auth)

17519 LIPID METABOLISM IN MATURING AND GERMINATING COTTON SEEDS AND THE EFFECT OF GAMMA IRRADIATION ON THIS PROCESS. A. G. Vereshchagin and M. Ganieva (Inst. of Plant Physiology, Moscow). Biochemistry (USSR) (English Transl.), 29: 249-58(Mar.-Apr. 1964). Translated from Biokhimiya, 29: 288-99(Mar.-Apr. 1964).

The triglyceride fatty acid composition of maturing cotton seed of the variety S-1622 did not change markedly from the 30th to the 80th day after fertilization. Cotton varieties of the species Gossypium hirsutum L., differing in earliness of maturation, had almost the same fatty acid and triglyceride composition. During germination of seeds of the variety S-1622, the fatty acids composition in the total lipids of the cotyledons showed significant changes; the appearance in the lipids of linolenic acids, which was absent in the oil of maturing and ripe seeds, was observed. The cotyledons contained the following classes of lipids: free fatty acids, unidentified lipids, triglycerides, and sterol esters. Free fatty acids, whose structure was little affected by γ irradiation, evidently arise from the breakdown of phospholipids during the process of fixing the material. The metabolism of complex esters of fatty acids and sterols had a significant degree of resistance to γ irradiation. During germination, there was observed in the structure of the seed reserve substances — the triglycerides — transition of part of the palmitic acid to stearic acid, and also interconversion of oleic, linoleic, and linolenic acids. The content of linoleic acid was reduced during germination while the contents of oleic and linolenic acids increased. Irradiation of swelling seeds prior to germination (200 R, ^{60}Co) had a marked effect on the orientation and rate of interconversion and synthesis of the glyceride fatty acids, and also on the synthesis of the triglycerides themselves. Ionizing radiation sharply increased the conversion of linoleic acid in the triglycerides to linolenic acid and increased the rate of interconversion of other fatty acids. The linolenic acid developing in nonirradiated cotyledons formed predominantly trilinolenin and linoleodilinolenin, while in the absence of irradiation, triglycerides with 7 double bonds were the main type formed. Thus, simultaneously with the utilization of triglycerides in cotton seedling cotyledons, there occurred active synthesis of lipids — the formation of fatty acids not usually found in the structure of reserve oil, new triglycerides, and also synthesis of sterol esters. (auth)

17520 DEVELOPMENT OF CHANGES IN BONE MARROW IN MICE AFTER IRRADIATION IN THE CONDITION OF HYPOTHERMIA. Milan Prasličkа and Zdenek Karpfel (Univ. of Safarik, Czechoslovak Academy of Sciences, Kosice and Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Biologia, 19: 836-42(1964).

Changes in the bone marrow of mice irradiated with a dose of 500 R were studied. In animals maintained for 48 hours after irradiation at a body temperature of 22–25°C all the changes took place more slowly, but in the same direction as the animals that were not under the condition of hypothermia. In the relative picture of the myelogram, and in the absolute values of cellularity the picture of the bone marrow in the mice subjected to hypothermia was similar after 48 hours, to that of control mice after 16 hours. (OTS)

17521 INCREASE IN PLASMA ANTITHROMBIN ACTIVITY FOLLOWING TOTAL BODY EXPOSURE TO SMALL AND MEDIUM DOSES OF ROENTGEN RAYS IN DOGS. Ctirad Svehla, Konrad Rysanek, Jiri Koenig, Helena Spankova, and Miloslava Mlejnkova (Research Inst. for Experimental Therapy Medical Clinic of the Post-graduate Medical School, Prague). Blood, 25: 622-5(Apr. 1965).

The effects of low and medium x-ray doses on increased antithrombin activity in the blood plasma in dogs is reported. This phenomenon showed some features of heparinoid activity, which may be ascribed to the increase of protein-bound polysaccharides observed following irradiation. It also seems likely that this increase in antithrombin activity would be a regular but by far not major component of the complex of blood clotting disorders after any kind of irradiation. (P.C.H.)

17522 THE GAMMA RADIATION FIELD AT "EL ENCIN" (ALCALA DE HENARES). C. Gomez Campo and M. Casas-Builla (Instituto Nacional de Investigaciones Agronomicas, Madrid). Bol. Real Soc. Espan. Hist. Nat. Secc. Biol., 62: 115-22(1964). (In Spanish)

The "El Encin" fields used for studies of the effects of gamma radiation on crops are described. The ^{137}Cs γ source and a tabulation of the experimental works carried out are considered. (J.S.R.)

17523 MODIFICATIONS OF THE NUCLEOTIDE METABOLISM IN THE LIVER OF RATS IRRADIATED WITH ^{60}Co. C. M. Caldarera, V. Pasquinelli, and M. Marchetti (Universita, Bologna). Boll. Soc. Ital. Biol. Sper., 39: 1822-4(1963). (In Italian)

Concentration in nucleic acids, free nucleotides, and the enzymatic activity of polynucleotide-phosphorilase and aspartic-transcarbamilase of the liver of rats exposed to a dose 600 R gamma radiation was determined. A significant increase both in the RNA and DNA was observed 48 hr after irradiation. Profound modifications were observed in the nucleotide spectra 48 hr after the irradiation. The phosphorylase activity was significantly reduced, but the transcarbamilase was increased after 48 hr. Thirty days after irradiation no significant variations were observed between the controlled and irradiated groups except for the free nucleotides. The significance of these results are discussed. (J.S.R.)

17524 EFFECTS OF IRRADIATION ON THE LIPID METABOLISM: THE COURSE OF HYPERLIPEMIA IN THE IRRADIATED RAT. R. Angelico, G. Casparrini, G. Cavina, L. Moretta Maggiore, and M. Quintiliani (Istituto Superiore di Sanita, Rome). Boll. Soc. Ital. Biol. Sper., 39: 1785-8 (Dec. 31, 1963). (In Italian)

Long-Evans adult rats, after being fasted for 12 hr, were irradiated with 220-kv x rays at 44 R/min and total focal doses of 1000 R. Afterwards, the animals were fasted and received only water. To determine the total serum and liver lipid levels the animals were sacrificed at intervals of 12, 24, 36, 48, 60, 72, and 96 hrs. The following values for total liver lipids (as mg% fresh wt) were observed in the controls and in the irradiated animals as these respective times:

77, 66; 60, 56; 76, 67; 64, 58; 54, 56; 57, 58; 60, 62. After 36 hrs a marked increase (47%) of the total serum lipid was observed. The maximum of 76% was reached after 72 hrs, and the dying animals showed an increase of 41% after 96 hrs. The irradiated animals showed a considerable liver weight increase in comparison to the controls. The changes in fresh weight of the liver at the respective intervals 12 to 96 hr postirradiation were: −14%, +16%, +16%, +32%, +35%, +26%, and +10%. Symptoms of radiation-caused hyperlipemia were observed, but the total liver lipid content remained unchanged. (BBB)

17525 EFFECTS OF IRRADIATION ON POLLEN. I. IRRADIATION EFFECTS OF γ-RAYS ON POLLEN-TUBE MITOSIS. Yozo Iwanami (Yokohama Municipal Univ., Japan) and Seiji Matsumura. Botan. Mag. (Tokyo), 76: 246-55(July 25, 1963).

The effects of pollen grain irradiation on pollen-tube mitosis were investigated. The data were obtained from artificial culture. For irradiation gamma rays were applied with ^{137}Cs 6,000 C at a dose rate 55 kR/hr. The doses ranged from 0.5 to 100 kR. Inhibition of mitosis increased with increasing dose; namely the higher the dose, the more reduced was the frequency of nuclear division and the more delayed was the time of its occurrence. In Lilium auratum the generative nucleus remained mostly undivided in showing chromosome elements even at 5 kR, while at 20 kR a few nuclei consisted of chromatin masses or chromosomes. The pollen-tubes of Lilium did not grow smoothly on the media. In natural condition, therefore, their pollen-tube mitosis may be more radioresistant. At 80 kR irradiation of Camellia japonica pollen the mitotic division of the generative nucleus was almost completely inhibited. In Camellia sasanqua the generative nucleus did not divide into 2 sperm nuclei above 25 kR, while relatively many generative nuclei with chromosomes were observed at 50 kR. The pollen grains of Impatiens balsamina had the highest radioresistance. At 50 ~ 80 kR the generative nucleus underwent complete mitotic division. Radiosensitivity of pollen grains varied widely according to the species. In general, their pollen-tube mitosis was much more radioresistant than the meiosis in PMC's and mitosis in root tips. (auth)

17526 EFFECT OF OX ON THE PROLIFERATION OF MICROORGANISMS. [PART] I. Goki Yamamoto (Okayama Univ., Japan). Bull. Cancer Inst. Okayama Univ. Med. School, No. 1, 92-7(Aug. 30, 1961).

OX is an unsaturated fatty acid fraction extracted from the liver of x-irradiated rabbits, previously shown to be effective in the treatment of cancer. It is believed to attack cancer cells in two ways: directly on the cell membrane bringing about the cell destruction, and it is also taken into the cell as a metabolic inhibitor. To elucidate the mechanism of its antimetabolite action, experiments were conducted to see if OX affects the proliferation of microorganisms as seen by biochemical procedures, using Saccharomyces carlsbergensis. This yeast does not proliferate in medium containing glucose under anaerobic condition but does proliferate in medium containing a lipid such as cholesterol, lecithin, or unsaturated fatty acid, under anaerobic condition. Thus, observations were conducted to see whether OX inhibits lipid metabolism of these microorganisms proliferating in the medium containing lipid under anaerobic condition. In Sabourand's medium, using glucose as the energy source, the cells proliferated to a fair degree although the conditions of the medium were not favorable. Glucose played an important role in the cell proliferation. Under anaerobic condition with glucose as the substrate the proliferation of S. carlsbergensis was inhibited; however, when cholesterol and lecithin were added to the medium, the microorganisms proliferated, utilizing these substrates as an energy source. When OX was added to the culture medium containing glucose under aerobic conditions, it acted as an inhibitor of cell growth. OX inhibited to a marked degree the proliferation of yeast in the medium containing cholesterol under anaerobic conditions. Thus this substance appears to act as antimetabolite of cholesterol metabolism. OX is an unsaturated fatty acid and its biological action is in many respects similar to the effect of x rays, and it seems to act mainly on respiratory enzyme activities and on nucleic acid metabolism. (BBB)

17527 SOME LESSONS RESULTING FROM THE APPLICATION OF IONIZING RADIATIONS IN MUTAGENESIS IN FORAGE GRASSES. R. De Loose and H. Reyntens. Bull. Inst. Agron. Sta. Rech. Gembloux, 31: 570-5(1963). (In French)

The radiosensitivity of perennial R.v.P. pasture rye grass seed with respect to acute treatment with x radiation and a semi-chronic treatment with ^{60}Co γ rays was studied as a function of the percentage humidity of the seeds and the pregermination storage. The mutagenesis resulting from a special treatment with ^{32}P in the preflowering stage followed by controlled pollination between 2 sister plants obtained by forced self-pollination of the mother plant is reported. (tr-auth)

17528 SOME SUPPLEMENTARY DATA CONCERNING THE INFLUENCE OF γ RAYS ON WORKER BEES. C. Pelerents and J. van den Brande. Bull. Inst. Agron. Sta. Rech. Gembloux, 31: 576-83(1963). (In French).

The reactions of bees immediately after irradiation with doses of 40,000, 50,000, and 60,000 Rad is to form swarms that separate only after 6 or 7 hours. Higher doses produce an atony. The effects of γ rays on the life span and on the consumption of candy were determined. Doses higher than 10,000 Rad affects the construction of the combs. Doses below 15,000 Rad do not affect the production of combs. (J.S.R.)

17529 EARLY CHANGES IN THE GROWTH ZONE OF RAT INCISORS FOLLOWING IRRADIATION WITH X-RAYS. B. B. J. Soska (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Stomatol., 64: 246-50(1964).

Studies were made of changes in the growth zone in the apical portion of rat incisors following application of single doses of x rays in amounts of 200, 600, 1200, 2400, and 4800 R at intervals of one, three, and seven days after irradiation. Changes occur only after irradiation with a dosage of at least 600 R. According to the intensity of radiation applied and according to the time interval from its application, changes are characterized by varying degrees of edema affecting the growth zone and the apical periodontium, by hyperaemia, structural and regressive changes of cells of the odontogenic epithelium, which later almost completely disappear following irradiation with doses of 2400 R and more. Damage to and disintegration of the odontogenic epithelial cells result in delay or even complete arrest of growth or rat incisors. Only partially damaged cells in the zone of growth produce hypoplastic enamel and dentine of osteoid character. Mature dental tissues become separated from tissue damaged by radiation by hyaline calcifying masses, which eventually resemble osteodentine. Reparative changes, which teeth are still capable of if irradiated with doses of up to 2400 R, are characterized by connective tissue proliferation in the originally oedematous tissue and by organization of hemorrhagic foci in conjunction with restoration of the structure of the odontogenic epithelium. Restitutio ad integrum is the rule after doses not exceeding 1200 R, permanent functional damage to the growth zone, however, results if the dosage surpasses 1200 R. (Excerpta Med., Sect. XXIII, 2: No. 2(Feb. 1965))

17530 DETECTION OF HAPLOID PLANTS AMONG THE DESCENDANTS FROM THE CROSS BREEDING BETWEEN NICOTIANA TABACUM L. AND NICOTIANA SANDERAE HORT, AFTER IRRADIATION OF THE POLLEN. Hubert Dulieu (Laboratoire de Cytogenetique, Louvain, Belg.). Compt. Rend., 259: 4126-9(Nov. 30, 1964). (In French)

The irradiated pollen of Nicotiana sanderae Hort (n = 9), which gives with Nicotiana tabacum L. (n = 24) a high rate of embryonic lethality in F_1, made it possible to adjust six plants of N. tabacum to 2n = 24, a plant of maternal type becoming amphidiploid and an aberrant plant more haploid

(2n = 24); among the hybrids (2n = 33) numerous individuals are abnormal. The presence of meiotic association indicates a certain homology between the two base genomes of N. tabacum. An aberrant type with 24 chromosomes can indicate that there is, in some cases, exchange of irradiated material. (tr-auth)

17531 ULTRASTRUCTURAL ASPECT OF PRECOCIOUS RADIOLESIONS PRODUCED BY A STRONG DOSE OF X RAYS ON THE EMBRYONIC HEART IN ORGANOTYPE CULTURE. Jean-Michel Kirrmann, Georges Le Douarin, and Danielle Cuminge (College de France, Paris and Centre National de la Recherche Scientifique, Nogent-Sur-Marne, France). Compt. Rend., 260: 671-3(Jan. 11, 1965). (In French)

An electron microscopic examination of myocardium cells of the chicken embryo fixed a half-hour after irradiation in vitro with 30 kR revealed some types of lesions located principally at the level of the nuclear membrane which became irregular and fragmented. Alterations of the cellular membrane, mitochondria, and ergastoplasm, as well as a rarefication of the ribosomes in certain regions of the cell, were also observed. The myofibrils were not modified. (tr-auth)

17532 ACTION OF X RAYS ON THE GERMINAL LINE AND THE REGENERATION OF GENITAL APPARATUS OF ASTERINA GIBBOSA PENN (ECHINODERM). Michel Huet (Faculte des Sciences de Paris, Orsay, France). Compt. Rend., 260: 707-9(Jan. 11, 1965). (In French)

Asterina gibbosa (Penn) has a distinct germinal line of the somatic line. More sensitive than the somatic tissues, the germinal tissue can be destroyed by x rays. In this case, an excised gonad can not be regenerated. This regeneration is possible if a part of the germinal cells (non-irradiated aboral ring) are not exposed to the radiation. (tr-auth)

17533 X-RAY-INDUCED MUTATIONS IN CULTIVATED RICE, N. P. 130. S. V. S. Shastry and G. V. Nadhachary. (Indian Agricultural Research Inst., New Delhi, India). Current Sci. (India), 34: 55-6(Jan. 20, 1965).

Dry, dormant seeds of the cultivated rice variety N. P. 130 were irradiated with x rays at four doses of 11, 22, 33, and 44 kR. Viable mutations secured in M_2-M_4 generations of the rice along with their inheritance are discussed. Dwarf mutations were the most frequent of all the viable mutations and were secured in 4 different M_1 plant progenies, out of 99 tested. All dwarfs observed were controlled by a single recessive gene. Rolled leaf mutation was secured in a single M_1 plant progeny 13-11 and its occurrence coincided with that of dwarf mutation. In some M_3-M_4 progenies tracing to two different M_1 plants, shy tillering mutant was recorded. These mutants exhibited a solitary tiller that flowers and sets seed normally. This character was also controlled by a single recessive gene. (P.C.H.)

17534 A RADIATION-INDUCED USEFUL MUTANT OF ANNUAL CHRYSANTHEMUM. R. S. Rana (Indian Agricultural Research Inst., New Delhi, India). Current Sci. (India), 34: 58(Jan. 20, 1965).

Striking changes affecting the flower form were observed in M_2 population of a single type Chelsea variety of Chrysanthemum carinatum when dry seeds were subjected to an x-ray dose of 15 kR. The mutant types included a change from single type flower-heads into double type and conversion of open type ray florets into tubulars. Of particular interest was a mutant having bisexual ray florets instead of the usual pistillate type. Breeding analysis showed that this mutant condition was determined by a recessive gene. Both the pollen and the seed fertility of the bisexual ray florets were normal. (P.C.H.)

17535 THE CLINICAL FEATURES OF DIABETES MELLITUS IN JAPAN AS OBSERVED IN A HOSPITAL OUTPATIENT CLINIC. Sunao Wada, Shintaro Toda, Yoshiaki Omori, Michiro Yamakido, and William G. Blackard (Atomic Bomb Casualty Commission, Hiroshima). Diabetes, 13: 485-91(Sept.-Oct. 1964).

A University diabetes clinic in Hiroshima, Japan was characterized in terms of age, age at onset, sex ratio, microangiopathies, neuropathy, atherosclerotic complications, weight, heredity, and diet. The findings in the clinic, along with those from other diabetes clinics in Japan, were compared with studies on Western diabetics. The similarities between the two diabetic populations in clinics far outnumbered the dissimilarities. However, diabetes mellitus in Japanese diabetes clinics is distinguished by the infrequent occurrence of juvenile diabetes and ketosis, relative lack of atherosclerotic complications, and reversal of the sex ratio. (auth)

17536 THE EFFECT OF γ IRRADIATION ON THE PHYSIOLOGICAL RESPONSES OF THE NERVE-MELANOPHORE SYSTEM IN CARASSIUS. Hisayoshi Eto (National Inst. of Radiological Sciences, Chiba, Japan). Dobutsugaku Zasshi, 72: 277-82(Dec. 1963). (In Japanese)

Isolated caudal fins of carassius were used as test materials. A 10^{-6}M solution of adrenaline was used as the concentrating agent, and a 5×10^{-5}M solution of atropine as the disperser. In order to stimulate the nerve endings, M/7.5 KCl was used as the concentrating agent and M/7.5 NaCl as the dispersing agent. Stimulation by electric current was used for excitation of the concentrating nerve fibers. The response of the melanophores to the stimulation was photoelectrically recorded. The response of the melanophores to adrenaline or atropine was recorded for each fin. The fins were irradiated with ^{60}Co γ rays at doses of 62.5, 125, 250, 375, 500, and 625 kR. The fins were retested with the same chemical drugs after irradiation. The dose-response curves for the irradiated melanophores were sigmoid weak, but definite responses to the both agents were still recognizable even after 625-kR irradiation. The doses used for the nerve endings were 62.5, 125, 250, and 375 kR; the curves obtained were of convex shape. The responses to KCl and NaCl disappeared after irradiation of 375 kR. The doses used for the concentrating nerve fibers of the malanophores were 62.5, 125, and 250 kR. The results obtained were similar to those of the concentrating nerve endings, but the responses to electrical stimulation disappeared after irradiation of 250 kR. Radiation had a more harmful effect on the dispersing process of the nerve-melanophore system than on the concentrating process. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964)).

17537 MANGANESE, NICKEL, AND CHROMIUM IN EXPERIMENTAL RADIATION SICKNESS IN GROWING ANIMALS. V. A. Boyko (Grodno State Medical Inst., USSR). Dokl. Akad. Nauk Belorussk. SSR, 8: 332-3(May 1964).

The results of experiments that were carried out to determine the effects of penetrating radiation on the content of manganese, nickel, and chromium in the blood and other organs of growing animals are reported. Twenty puppies were used. Radiation sickness was induced in the animals by exposing them to the action of x rays in a dose of 500 R. The blood content of the microelements was determined before and after the exposure of the animals to penetrating radiation. All of the animals perished within 13 to 54 days after their exposure to whole-body radiation. Postmortems were performed and the concentrations of the elements in the liver, spleen, and sternum were determined. It was found that as a result of radiation, the blood content of manganese increased from 21 to 30 gamma %; that of nickel decreased from 28.2 to 15.7 gamma %; and that of chromium decreased from 11 to 6.3 gamma %; that the manganese content in the liver increased, while that of nickel and chromium decreased; corresponding modifications were noted in the other organs. The results indicate that an increase in the organ content of manganese is accompanied by a decrease of the other two elements. Greatest modifications were found in the blood, liver, and spleen. This fact provides a basis for the assumption that the microelements in question take part in the hemopoietic process, and play an important part in the pathogenesis of radiation sickness. (CFSTI)

17538 ANTIGENICITY OF IRRADIATED CELLS. Vera Haskova and I. Hilgert (Inst. of Experimental Biology and Genetics, Czechoslovak Academy of Sciences, Prague). Folia Biol. (Prague), 11: 41-7(1965).

It was found that the receptors of isoantigens in the homologous mouse system are not directly impaired by large doses of x irradiation (15,000 R) in vitro. The immunological response to cells whose capacity to repopulate had been abolished by irradiation, was compared with the immunological response to non-irradiated cells to determine the part played by repopulation in the antigenicity of cells. The follow-up of cellular immunity by means of the second set reaction, induced by a previous dose of spleen cells, showed that an approximately 10–20 times larger number of irradiated than non-irradiated cells were necessary to obtain the same effect. The difference in effectiveness of irradiated and non-irradiated cells is of three orders, if tumor cells are used. The duration of sensitivity was also shorter, when irradiated cells were used. The titre of humoral antibodies was almost the same after the administration of irradiated and non-irradiated cells; however, with irradiated cells, the peak in antibody formation was reached on the 5th day already and decreased rapidly, whereas after sensitization with repopulating cells, the peak was attained on the 9th–11th day and decreased more slowly. Immunological tolerance to skin grafts could be induced by heavily irradiated spleen cells, but a large number of cells and a suitable schedule of administration were necessary. (auth)

17539 SPORES OF MICROORGANISMS. XVI. A CONTRIBUTION TO THE STUDY OF COMBINED RADIATION- AND HEAT-INACTIVATION OF BACTERIAL SPORES. V. Vinter and B. Vechet (Inst. of Microbiology, Czechoslovak Academy of Sciences, Prague). Folia Microbiol. (Prague), 9: 352-7(1964).

The heat inactivation of spores of Bacillus cereus, x irradiated or non-irradiated was investigated with respect to their dipicolinic acid (DPA) content. Spores with a high DPA content (98 μg/mg dry weight) displayed a biphasic heat inactivation curve. This biphasic character of the curve was preserved for the heat inactivation of previously irradiated spores even if the length of the initial lag of inactivation rate was reduced. Spores with a lower DPA content (24 μg/mg dry weight) displayed a single-phase logarithmic order of dying from the beginning of heating. In both types of spores differing in the DPA content a pronounced sensitization of radiation-surviving spores toward subsequent heating was observed. (auth)

17540 EFFECTS OF CHRONIC AND ACUTE GAMMA IRRADIATION OF MALE FLOWER BUDS AND MATURE POLLEN IN QUERCUS. G. R. Stairs (Brookhaven National Lab., Upton, N. Y.). Forest Sci., 10: 397-409(Dec. 1964).

Production of pollen under chronic gamma irradiation was investigated for three Quercus species in a forest surrounding a Cs-137 source of approximately 9500 Curies. Evaluations were made after 5 months of radiation exposure and again after 17 months of exposure. In both studies pollen abortion and a delay in floral phenology increased with increasing radiation exposure. Germinable pollen was produced at all survival levels examined and no significant decrease in tube length was found. Acute irradiation of male flower buds at different stages of meiosis, and of mature pollen was reported. The radiosensitivity of microsporogenesis was evaluated by cytological scoring at anaphase I, and by pollen abortion, germination, and tube length. Both chromosome aberration and pollen abortion showed a linear increase with an increase in radiation exposure. The range of 1 to 4 kR was suggested as an appropriate exposure, for male flower buds to be utilized in a mutation breeding program. Pollen was highly resistant to radiation when evaluated by germination and tube growth studies. No effect was found with irradiation of 100 kR; at 300 kR both germination and tube lengths depressed. At these levels germination is probably an expression of cytoplasmic growth and not of nuclear viability. Pending additional studies the range of radiation recommended for flower buds is also suggested for the induction of mutations in pollen. No significant difference was found between species for either chronic or acute irradiation. (auth)

17541 SUPPLYING WATER TO ARMIES ON CAMPAIGN. A. Cier (Faculté de Médecine et de Pharmacie, Lyon). Gaz. Med. France, 71: 2179-87(June 10, 1964). (In French)

Among methods for water purification considered is the use of ionizing radiations. The radiolysis reactions which lead to formation of free radicals and destruction of microorganisms are also discussed. (BBB)

17542 FURTHER EFFECTS OF THE PIGMENT-RESTRICTING GENE, M, IN POTATOES: HIDDEN SPOTTED AND SPECTACLED. H. W. Howard (Plant-Breeding Inst., Cambridge, Eng.). Heredity, 19: 349-56(Aug. 1964).

The cross between a potato with white-splashed-pink tubers in which the pigment is in the periderm cells (DEM) and a potato with uniform pink tubers in which the pigment is in the phelloderm cells (DR) produced seedlings that have white, splashed pink (DEM), uniform pink (DR) or hidden spotted (DREM) tubers. Removal of eyes from a hidden spotted tuber resulted in plants originating from the adventitious buds on the treated tuber producing spectacled tubers. X-ray treatment of hidden spotted tubers also led to plants with spectacled tubers. The change by eye-excision or x-ray treatment of hidden spotted to spectacled tubers was analogous to the change from splashed to white tubers. Under conditions of vegetative reproduction the spectacled tubers gave rise to plants which also had some spectacled tubers but there was a marked reversion to hidden spotted. It is suggested that, in addition to inhibiting pigment formation in the periderm in areas away from the eyes, the gene M also inhibits pigment formation in the phelloderm in areas around the eyes. It is probable that the effect of the gene M is by way of the cytoplasm and that this explains the persistence under vegetative reproduction of the change from splashed to white and from hidden spotted to spectacled. (auth)

17543 ATOMIC-BOMB EXPOSURE AND ABSENTEEISM AMONG SHIPYARD WORKERS. Teizo Komatsu, Komei Hashimoto, Shigeyoshi Onishi, and Hideo Fujisawa (Mitsubishi Shipyard Hospital, Nagasaki). Hiroshima Igaku, 16: 258-68(1963). (In Japanese)

A total of 1220 Mitsubishi Shipyard male workers who had been employed continuously from 1954 through 1959 were subjected to a study for the detection of possible sequelae to exposure in the atomic bombing of Nagasaki. Three groups were classified and compared: 415 workers who were within 2000 m from the hypocenter at the time of explosion, 400 who were within 3000 to 3999 m, and 406 who were not in the city at the time. These groups were compared for absenteeism in terms of rate, frequency, and length of time. It was found that the rate of absenteeism (number of absences/total number of workers) among the three groups was almost the same (~0.20). There were more complaints of acute symptoms among those who were within 2000 m of the hypocenter than among the other groups more distantly exposed and unexposed. The rate of absenteeism tended to increase with the amount of radiation the workers received, although the relation was not statistically significant. Absenteeism due to gastrointestinal illnesses was highest among the long-distance and control groups, while absenteeism due to respiratory illnesses was highest among the short-distance group. However, in general, the rate of occurrence of atomic-bomb-related illnesses did not vary significantly among the three groups. (BBB)

17544 ON THE VIABILITY OF BOVINE SPERMATOZA BY γ-RAY IRRADIATION. II. THE EFFECT OF RADIATION ON THE SPERMATOZOA. Ryoichi Tanaka (Ibaraki Univ., Mito City, Ibaraki Prefecture, Japan) and Hisaji Kashiwabara. Ibaraki Diagaku Nogakubu Gokujitsu Hokoku, No. 11, 71-4(Oct. 1963). (In Japanese)

The effects of γ irradiation on bull semen (dilute suspension) were studied. A 1000-curie cobalt-60 γ irradiation was prepared with single dosages ranging from 1×10^4 to 1×10^6 R. Glass ampules containing the semen suspension

were put into a special vacuum flask about 16 cm high and 2.5 cm in dia and cooled with crushed ice. The viability of spermatozoa was measured by the Blom method. The results indicated that the dosage that caused cessation of movement of spermatozoa 6 hours after irradiation is about 50×10^4 R. The dosage survival curve of irradiated bull spermatozoa was similar to a hyperbola. In a preservation test of irradiated semen, longevity of spermatozoa was affected by dosage rate; namely, the longevity was retarded more by a high dosage rate than by a low dosage rate. (auth)

17545 RECENT ADVANCES IN RADIATION BIOLOGY. E. L. Powers (Argonne National Lab., Ill.). Illinois Med. J., [126: No. 3], 4p.(1964).

Recent advances in radiobiology with interesting implications for human biology are reviewed. Included are advances in cellular biology, the oxygen effect, chemical modification of response, biological modification of response, radiation genetics, and leukemogenesis. (P.C.H.)

17546 ANTIBODY FORMATION IN THE RECIPIENTS OF TISSUE CULTURED SPLEEN CELLS. Ann M. Dresser (St. Mary's Hospital Medical School, London). Immunology, 8: 69-73(1965).

Spleen cells from immunized mice were cultured in vitro and after varying durations of time these cells were injected into irradiated, isogenic hosts. The immune responsiveness of the recipient animals was then measured. Responses became progressively smaller when the cells were cultured for increasing lengths of time. Since the rate of cell death, as measured with vital stains, was less than the rate of decrease in the magnitude of the immune response, it is suggested that some form of irreversible transformation of the cells responsible for the secondary response may have occurred in vitro. It was not clear whether cell death or cell transformation accounts for the loss of the ability of the cultured cells to form antibody after transfer. The increased cell mortality observed after culture suggests that cell death is responsible. It cannot, however, be the sole cause. Thus the response of the recipients of cells cultured for 4 hr is three-fold less than that of the group receiving noncultured, immunized cells and about three-fold more than that of the group receiving cells cultured for 24 hours. At this time, the percentage of dead cells is roughly the same as at the start of the experiment. Although the changes in the proportions of the different cell types during culture were not measured, it was noticed that many of the larger cells had disappeared after 24 hr of culture. This fact, together with the evidence that cell death may not be totally responsible for the observations, suggests that large lymphocytes are the memory cells responsible for the capacity to give a secondary immune response. (BBB)

17547 MUTATION OF CHOLERA VIBRIO BY EXPOSURE TO IONIZING RAYS. Satyen Basu (Calcutta National Medical Coll.). Indian J. Radiol., 18: 114-17(Aug. 1964).

Accepting the fact that bacteria can change their physical characters by spontaneous gene mutation and that the rate of mutation can be increased by exposure to ionizing radiation, experiments were conducted with Cholera vibrios by exposing them to soft and hard x rays in different doses. Young four hour broth cultures of Strain V 37 and strain T-27 were used. After exposure, which killed a good percentage of the vibrios, the irradiated culture as well as the nonirradiated controls were again grown in broth for three hours (to overcome any phenomenal lag) and samples were then plated on selective media in duplicate. Experiments were repeated with saline medium instead of broth. With soft rays exposure to a dose of 9000 to 12,000 R did not produce any significant change in the mutation rate to arginine and purine independence nor in streptomycin resistance. With harder rays and a dose between 6000 and 12,000 R a greater frequency of streptomycin resistant mutants in irradiated cultures as compared to controls were obtained. (P.C.H.)

17548 AN INVESTIGATION OF (A) VARIATION IN RATE OF DNA-SYNTHESIS DURING S-PHASE IN MOUSE L-CELLS (B) EFFECT OF ULTRA-VIOLET RADIATION ON RATE OF DNA-SYNTHESIS. P. P. Dendy and J. E. Cleaver (Cambridge Univ., Eng.). Intern. J. Radiation Biol., 8: 301-15(1964).

Mouse L-strain cells were grown in tissue culture and used for experiments when they were in the exponential phase of growth. Both autoradiographic measurements of the rate of DNA-synthesis and microspectrophotometric measurements of the total DNA-content were made on individual cells in normal cultures, in cultures that had been irradiated with ultraviolet light, and in cultures in which some of the cells had received a microbeam dose of ultraviolet radiation into an area of the nucleus approximately 3 μ in diameter. From the results, it was first possible to establish the relative lengths of the G_1, S, and G_2 phases of the mitotic cycle for this type of cell. A more detailed analysis of the results showed how the rate of DNA-synthesis varies through the S-phase, and the irradiation experiments indicated that when the rate of DNA-synthesis is used as a criterion of sensitivity, the sensitivity of the cells to ultraviolet irradiation increases steadily during the synthetic phase. (auth)

17549 RADIOSENSITIVITY OF HAEMOPOIESIS IN FISH. I. STUDIES AT 18°C. K. Sletten, D. Lockner, and G. Hevesy (Karolinska Institutet, Stockholm). Intern. J. Radiation Biol., 8: 317-28(1964).

The radiosensitivity of blood formation to ^{60}Co γ irradiation in tench kept at 18°C was studied. 1500 Rad depressed red blood values by 90%, whereas lymphocytes were depressed by 60% after 250 Rad. 1200 Rad depressed ^{59}Fe incorporation into fish erythrocytes by 50%. 2000 Rad had no effect on radio-iron incorporation into fish erythrocytes when the fish were kept at 5°C. Irradiation of fish blood in vitro increased radio-iron-uptake by erythrocytes, but not incorporation into hemoglobin. Doses up to 10,000 Rad had no influence on ^{59}Fe incorporation into haemolysates irradiated in vitro. 750 Rad depressed thymidine-^{3}H incorporation into kidney-DNA by 50%. It was concluded that radiation anemia in fish in contrast to that in mammals is mainly due to a hemolysis of erythrocytes. (auth)

17550 FURTHER OBSERVATIONS ON IN VITRO RADIOSENSITIZATION OF RABBIT ERYTHROCYTES BY IODOACETIC ACID AND RELATED SUBSTANCES. M. R. Bianchi, M. Boccacci, P. Misiti-Dorello, and M. Quintiliani (Istituto Superiore di Sanita, Rome). Intern. J. Radiation Biol., 8: 329-42(1964).

A number of compounds more or less related to iodoacetic acid (IAA) were tested for their radiosensitizing effect on rabbit erythrocytes. As reported previously, red cells irradiated in vitro with x rays lose the intracellular potassium and hemolyze as a function of radiation dose and, when they have been treated previously with IAA, their radiosensitivity increases up to four times. Bromoacetic acid, iodoacetamide, iodopropionic acid, N-ethylmaleimide, alkaline iodides, and molecular iodine all exhibited radiosensitizing ability. The sensitization occurred to the same extent, whether the samples were irradiated under atmospheric oxygen-tension or after flushing with oxygen or nitrogen. For all the halogenated compounds it occurred only if the substance was present in the system at the moment of irradiation. The sensitizing effect appeared to be independent of the alkylating ability of tested compounds, and of the inhibition of glycolysis and lowering of ATP-level in red cells. Experiments with iodoacetic acid-1-^{14}C showed that a significant amount of labeled compound binds to red cells, even after a previous incubation with the inert product. After irradiation with 79 kR of x rays, the radioactivity bound to the red cells as whole, and to the red-cell membrane, was considerably reduced. (auth)

17551 THE EFFECT OF RADIATION OF ARTIFICIAL NUCLEOPROTEINS. I. RADIOSENSITIVITY OF POLYADENYLIC ACID-POLYURIDYLIC ACID: BOVINE GAMMA-GLOBULIN COMPLEX. Steven A. Armentrout and William

A. Mills (Public Health Service, Rockville, Md.). Intern. J. Radiation Biol., 8: 343-52(1964).

An artificial nucleoprotein complex was prepared, using polyadenylic acid-polyuridylic acid and bovine gamma-globulin. When this compound received 10 to 100 Rad of x rays, alterations in the ultraviolet absorption spectrum, which were proportional to the amount of radiation absorbed, were demonstrated. The characteristic spectral changes appeared only when the complex was irradiated above the T_m when the polynucleotide component was in a randomly coiled state. Dissociation of the complex with agents known to alter hydrogen bonding resulted in the loss of radiosensitivity and disappearance of the spectral changes. The possible mechanisms that might produce this change are discussed, as well as the future applications of artificial nucleoproteins. (auth)

17552 CONTRIBUTIONS TO THE STUDY OF IMMEDIATE AND EARLY X-RAY REACTIONS WITH REGARD TO CHEMOPROTECTION. IX. X-RAY-INDUCED CORONARY OCCLUSION LEADING TO HEART DAMAGE IN RABBITS. H. B. Lamberts and W. G. R. M. de Boer (Rijksuniversiteit, Groningen, Netherlands). Intern. J. Radiation Biol., 8: 359-65(1964).

Irradiation caused atheromatotic changes in the coronary arteries, leading to occlusion of these vessels. In two out of ten animals, E.C.G. changes were found, which were characteristic for a myocardial infarct. This was confirmed at necropsy. One example is given of a young patient in whom radiotherapy was the cause of fatal pulmonary and myocardial fibrosis. (auth)

17553 THE EFFECT OF WHOLE- AND PARTIAL-BODY X-IRRADIATION ON THE METABOLISM OF COLLAGEN IN POLYETHYLENE SPONGES AND THE URINARY EXCRETION OF PYRROLE-2-CARBOXYLIC ACID. Kunio Konno, Knut R. Traelnes, and Kurt I. Altman (Univ. of Rochester, N. Y.). Intern. J. Radiation Biol., 8: 367-72 (1964).

The incorporation of glycine-2-^{14}C into sponge collagen was of the same magnitude in two different sponges implanted at different sites in the same animal. Partial-body, in contrast to whole-body x irradiation, had no effect on the incorporation of ^{14}C-labeled proline, hydroxyproline, and glycine into sponge collagen. Similar observations were made with respect to the specific activity of urinary PCA. Evidence is presented indicating the possible interference of ionizing radiation with the conversion of proline to hydroxyproline. Whole-body x irradiation had no effect on the metabolism of collagen from rat-tail tendon although in these same animals the specific activity of urinary PCA did undergo radioinduced changes. (auth)

17554 INCREASED ^{3}H-THYMIDINE INCORPORATION INTO DNA OF IRRADIATED SLIME MOULD. R. A. McGrath, R. W. Williams, and R. B. Setlow (Oak Ridge National Lab., Tenn.). Intern. J. Radiation Biol., 8: 373-80(1964).

Synchronous cultures of the slime mold Physarum polycephalum were incubated in ^{3}H-thymidine. Some cultures were exposed to 25 kR of x rays. The specific activity of DNA from irradiated cultures was 40% greater than that from non-irradiated preparations. Feulgen spectrophotometric measurements indicated the same amount of DNA per nucleus in both cases. After exposure of samples to ultraviolet light the proportion of thymine to thymine dimers was the same in irradiated and non-irradiated samples, indicating there had been no large addition of thymine to DNA. Heating and cooling in 1% formaldehyde did not release any pieces of low molecular weight that were separable from DNA on Sephadex columns, a finding that argues against loose association of precursor and DNA. The possibility that specific activity of the precursor pool may be changed by irradiation, or that replacement of damaged sites on DNA may occur, are offered as possible explanations. (auth)

17555 COINCIDENCE OF MUTATIONS AS A POSSIBLE CAUSE OF MALIGNANCY. R. H. de Waard (Rijksuniversiteit, Utrecht). Intern. J. Radiation Biol., 8: 381-7(1964).

Some implications of the hypothesis that x-ray induced, and perhaps other, malignant tumors may have their origin in somatic mutations are discussed. By arguments based on certain theoretical conceptions a value of the same order of 10^{-9} was obtained for the probability of a mutation involving the substitution of a particular amino acid in a definite protein by another one. This suggests that the appearance of a malignant tumor might be due to the substitution of two such amino acids by others. (P.C.H.)

17556 ABSENCE OF THE SYNERGISTIC EFFECT OF WHOLE-BODY IRRADIATION AND LOCAL TUMOUR IRRADIATION IN AN AUTOCHTHONOUS LYMPHOID TUMOUR SYSTEM. Gerald E. Hanks and Henry S. Kaplan (Stanford Univ., Palo Alto, Calif.). Intern. J. Radiation Biol., 8: 399-402(1964).

Mice bearing early radioinduced thymic lymphosarcomas were tested for potentiation, by small amounts of whole-body irradiation, of the curative effects of local tumor irradiation. No change in 50% curative dose was noted when 100 R of the total tumor dose was given as whole-body irradiation. (P.C.H.)

17557 THE FAILURE OF SULPHHYDRYL COMPOUNDS, AET, MEA, AND GLUTATHIONE TO PROTECT AGAINST X-RAY INDUCED CHROMOSOME ABERRATIONS IN MALE DROSOPHILA. Sidney Mittler (Northern Illinois Univ., DeKalb). Intern. J. Radiation Biol., 8: 405-13(1964).

Pre-treatment with the mammalian radioprotective sulfhydryl compounds AET, MEA, and glutathione did not protect the Drosophila testis from radio-induced genetic damage. Protection was not given to spermatozoa, spermatids, spermatocytes, and spermatogonia. The responses measured were production of recessive sex-linked lethals, translocations, deletions, loss of X and Y chromosomes and dominant lethals. MEA increased the recessive lethals in the 3-6 day brood. Pre-treatment with glutathione increased the incidence of XO males in the 6-9 day brood and post-treatment in 0-3 day brood. MEA and glutathione increased the percentage of eggs that failed to develop in dominant lethal tests. (auth)

17558 INACTIVATION OF BETA-AMYLASE BY GAMMA-RADIATION. Pietro Scoppa and Francesco Tafuri (Universita, Perugia, Italy). Intern. J. Radiation Biol., 8: 415-25(1964).

The inactivating action of gamma radiation on beta-amylase (barley) in aqueous solution is largely of the indirect type. The radiation effect can be modified by the addition of various compounds. The nitrite anion displays a strong protective action, and the chlorides of sodium and potassium act synergistically with the radiation. The nature of the radiation effect on the enzyme seems to be somewhat similar to that of strong oxidizing agents. (auth)

17559 TIME IN CULTURE. AN IMPORTANT VARIABLE IN STUDYING IN VIVO RADIATION-INDUCED CHROMOSOME DAMAGE IN MAN. Karin E. Buckton (Western General Hospital, Edinburgh) and M. C. Pike. Intern. J. Radiation Biol., 8: 439-52(1964).

Studies were made, on the blood of patients treated with x rays for ankylosing spondylitis, of the effect of time after exposure on the proportion of cells in blood-cultures with unstable chromosome aberrations (C_u cells), and also of the effect of time in culture on the proportion of C_u cells. It was found that the effect of prolonging culture time is a significant decrease in the numbers of C_u cells, and of the proportion of these that are probably in their first division since the production of radiation damage (X_1 cells). It was also found that, provided cells are harvested after about 48 hours in culture, the proportion of X_1 cells remains high, even though irradiation may have taken place several years previously. The implications of these findings are discussed in relation to making observations on chromosome damage after in vivo radiation exposure, and also in regard to the problem of the life-span of lymphocytes. (auth)

17560 IMPAIRMENT OF THE PROLIFERATIVE CAPACITY OF HUMAN CELLS IN CULTURE BY α-

PARTICLES WITH DIFFERING LINEAR-ENERGY TRANSFER. G. W. Barendsen (Radiobiological Inst., TNO, Rijswijk, Netherlands). Intern. J. Radiation Biol., 8: 453-66 (1964).

Inhibition of clone-formation was measured after irradiation of cultured human cells by α-particles with different ionization densities. The results show that the RBE of these particles, as a function of the LET, increases between 25 and 100 kev/μ of unit density tissue, passes through a maximum of about 8 at 110 kev/μ, and subsequently decreases. The effectiveness per particle, calculated as the effective cross-section for impairment of the proliferative capacity, increases between 25 and 100 kev/μ of unit density tissue and approaches a maximum of 35 μ^2 at higher LET values. These results are discussed on the basis of a hypothesis, whereby it is assumed that a given number of n or more ionizations must be produced within a length of the particle track t, in order to cause, through a cooperative action, damage to the reproductive capacity of the cells. (auth)

17561 A COMPARISON OF THE EFFECTS OF ACUTE AND PROTRACTED GAMMA-RADIATION ON THE GROWTH OF SEEDLINGS OF VICIA FABA. PART I. EXPERIMENTAL OBSERVATIONS. Eric J. Hall and Joel S. Bedford (Churchill Hospital, Oxford). Intern. J. Radiation Biol., 8: 467-74(1964).

Seedlings of Vicia faba were used to compare the effect of gamma radiation delivered over a wide range of dose-rates. The interpretation of radiation damage would be complicated if cell-division continued during the exposure and so seedlings were stored and irradiated at 3.5°C, at which temperature root growth and cell division in the meristem is temporarily halted. The radiation damage was assessed in terms of root-growth after the seedlings had been restored to 19°C. It was found that the effect of a given dose of radiation decreased as the dose-rate was reduced from 122 Rads/min to 8.4 Rads/hour, and again to 1.5 Rads/hour. However, subsequent lowering of the dose-rate to 0.89 Rads/hour did not further decrease the effect of the radiation. It was inferred that at these very low dose-rates, the processes of radiation damage are dose-rate independent, i.e., single hit processes. (auth)

17562 A COMPARISON OF THE EFFECTS OF ACUTE AND PROTRACTED GAMMA-RADIATION ON THE GROWTH OF SEEDLINGS OF VICIA FABA. PART II. THEORETICAL CALCULATIONS. R. Oliver (Churchill Hospital, Oxford). Intern. J. Radiation Biol., 8: 475-88 (1964).

Observations with Vicia faba on the reduction of root growth in ten days with increase of time-interval between two exposures, were analyzed and indicate an approximately exponential recovery in the dose equivalent of sub-lethal damage with time after the first exposure, half-times of about 0.7 and two hours applying at 19 and 3.5°C, respectively. Calculations were made of the theoretical dose response curves, which were derived for exposure at 8.4, 1.52, and 0.89 Rads/hour based on a survival curve for acute exposure of the form $S = \exp(-D/190)\{1 - [1 - \exp(-D/70)]^2\}$, consistent with the results of previous experiments. Theoretical values of acute exposures equivalent to various protracted exposures agreed well with the experimental results for 3.5°C where there was no significant cell-division during the exposure. (auth)

17563 THE EFFECT OF FRACTIONATED X-IRRADIATION ON THE TESTIS OF THE NEW-BORN RAT. N. A. J. Pereira (Univ. of Birmingham, Eng.). Intern. J. Radiation Biol., 8: 489-98(1964).

The testes of albino rats were exposed on the day of birth to a total of 18.7 R delivered in either one or two sessions. As judged by the population of spermatocytes at 15 days post partum, fractionated irradiation (interfraction interval 10 hours or less) exerted the same effect as acute irradiation. (auth)

17564 TENSION OF OXYGEN IN TISSUES AND ITS CHANGES DURING IRRADIATION. A. Vacek, E. Davidova, and B. Hosek (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Intern. J. Radiation Biol., 8: 499-506 (1964).

The tension of oxygen in the brain, liver, spleen, muscles, and subcutaneous connective tissue of mice was studied during irradiation at a dose-rate of 200 R/min and upon administration of thiopental. At the same time, the consumption of oxygen was followed up after both procedures. During irradiation there was a decrease of oxygen-tension in the muscle and spleen of the narcotized mice, which also continued after irradiation. Oxygen-consumption in mice irradiated at a rate 200 R/min decreased too. Agreement was found as to the time and trend of changes in the whole-body oxygen-consumption and tension of oxygen in tissues during irradiation. (auth)

17565 MICROBEAM AND PARTIAL CELL IRRADIATION. C. L. Smith (Cambridge Univ., Eng.). Intern. Rev. Cytol., 16: 133-53(1964).

A review is presented of the literature from 1957 to 1964 on microbeam and partial cell irradiation. New techniques for carrying out microbeam or partial cell α particle, ultraviolet or x irradiation of cells are described. Morphological and biochemical effects following irradiation of the nucleus, nucleolus, cytoplasm, and chromosomes of a variety of cells in tissue cultures and single-celled organisms are reported. Results are included from studies on the effects of radiation on DNA synthesis in which ^{3}H-thymidine was used as a tracer. (89 references.) (C.H.)

17566 NUCLEAR-CYTOPLASMIC INTERACTION WITH IONIZING RADIATION. M. A. Lessler (Ohio State Univ., Columbus). Intern. Rev. Cytol., 16: 155-72(1964).

Ionizing radiation is characterized biologically by its universality of action and variations in radiosensitivity found at different levels of biological organization. This difference in radiosensitivity is observed not only at phylogenetic levels but also among organs, tissues, and cells of an organism and nuclear and cytoplasmic components of individual cells. Data from recent studies are reviewed that demonstrate that the nucleus is an important synthetic locus containing many important enzyme systems for the production of both nuclear and cytoplasmic components and that the products of nuclear synthesis pass readily through the fenestrated nuclear membrane into the cytoplasm where they participate in many important functions. Nuclei have been shown to synthesize DNA, RNA, histones, proteins, lipids, and probably polysaccharides. The reactions of x and γ radiation in tissues are reviewed. Results are reviewed from studies of mechanisms involved in radiation injuries in amphibian eggs, comparative studies of nuclear and cytoplasmic radiation injuries, radioinduced nuclear damage and chromosome aberrations, radiation effects on DNA, radiation effects on amoeba, radiation effects on cytoplasmic structures, and theoretical studies of radiation effects using biological models. (C.H.)

17567 ANTIMICROBIAL EFFECT OF IRRADIATED GLUCOSE. Nils Molin (Swedish Inst. for Food Preservation Research (SIK), Goteborg). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138(1963),86-7(1964).

Antimicrobial effects of irradiated crystalline glucose dissolved in water and of irradiated aqueous solutions of glucose were studied, using a Pseudomona species. Killing of this organism through the action of irradiated glucose is demonstrated. The effect of irradiated crystalline glucose dissolved in water was several orders of magnitude less than the effect of irradiated aqueous glucose solutions. The biologically active degradation products formed seemed to be rather stable. (M.C.G.)

17568 EFFECTS OF IONIZING RADIATION ON THE HEART. S. G. Antonyan (Inst. of Biophysics, Ministry of Health, USSR and Inst. of Cardiology and Heart Surgery, Erevan). Izv. Akad. Nauk Arm. SSR, Biol. Nauki, 17: No. 7, 45-54(July 1964).

Indirect effects of ionizing radiation on the heart are reviewed on the basis of published data in the subdivisions of reactions of the normal heart to ionizing radiation and radiation injury and reactions of a functionally modified heart to the same effects. In the second subdivision the interrela-

tions between nervous and physical strain, hypoxia, hibernation, pathological conditions of the heart, and the action of the heart, and the action of mediator hormones (adrenalin and acetylcholine), on the one hand, and the effects of ionizing radiation, on the other hand, are discussed in some detail. It is brought out on the basis of animal experiments that a moderate amount of exercise may alleviate the harmful effects of ionizing radiation on the heart and on the organism in general. (CFSTI)

17569 ON THE RADIATION SENSITIVITY OF VARIOUS CORN VARIETIES. V. O. Babayan, D. O. Avakyan, and R. A. Azatyan (Lab. of Radiation Genetics, Academy of Sciences, Armenian SSR). Izv. Akad. Nauk Arm. SSR, Biol. Nauki, No. 8, 93-6(Aug. 1964).

Studies were made on the yields and plant weight of corn crops from seed subjected to ionizing radiation (100, 500, and 700 R), and the extent of mutation in the second generation was determined. It was concluded that resistance of organisms to ionizing radiation depends in great part on the genetic makeup of the organism. The conditions, including the genetic makeup, which result in increased vitality and productivity of the organisms, also increase the radioresistance. (OTS)

17570 SELECTION OF ACTIVE STRAINS OF COELICICOMYCIN PRODUCERS USING ULTRAVIOLET RAYS. M. Kh. Shigaeva and V. D. Sivertseva. Izv. Akad. Nauk Kaz. SSR, Ser. Biol. Nauk, No. 1, 53-7(1964).

As a result of irradiating spores of Actinomyces coelicolor strain $^{17}/_{65}$ three times and then selecting active variants, three mutant strains were produced which synthesize two times more antibiotic than the initial culture. Antibiotic activity of these mutants was higher in the medium in which the selection was made; activity was highest in Chapek's medium and amounted to 128, 192, and 256 units/mg. It was established that succeeding irradiations (second and third) reduce the selection rate but increase the stability of the mutants. (OTS)

17571 THE EFFECT OF OCCUPATIONAL EXPOSURE TO RADIATION ON THE MORTALITY OF PHYSICIANS. Raymond Seltser and Philip E. Sartwell (Johns Hopkins Univ., Baltimore). J. Am. Med. Assoc., 190: 1046-8 (Dec. 21, 1964).

Attempts were made to obtain further data in answer to the question: does occupational exposure to x rays on the part of radiologists shorten their lives? Statistical data were obtained from three medical specialty societies, chosen on the basis of amount of presumed average exposure of their members to x rays in the course of their professional activities. The societies chosen, in order of presumed diminishing exposure were: The Radiological Society of North America (RSNA), the American College of Physicians (ACP), and the American Academy of Ophthalmology and Otolaryngology (AAOO). All male physicians, who practiced in the United States and became members of these organizations from 1915 to 1954, were included. The numbers of subjects, person-years contributed, and deaths by time periods in the main societies, as well as the death rates by 15-year age classes (age-adjusted by five-year groupings), are tabulated. At the combined ages, the rank order of mortality was RSNA > ACP > AAOO in each time period. This same rank order was present at ages 50 to 64 and 65 to 79 in all three time periods. It was absent at ages 35 to 49 except in the first time period. The differences between societies became smaller with the passage of time, and persisted only in the older age classes. Members of the RSNA were matched for age and for five-year period of entry with corresponding members of the AAOO for those entering their societies between 1921 and 1939, and between 1940 and 1954; of the first group, 440 RSNA and 344 AAOO members had died and of the second, 70 RSNA and 83 AAOO members had died. This independent method demonstrates the reality of the difference in mortality risk and its disappearance in the later period. The results support the hypothesis that occupational exposure to ionizing radiation has had a life-shortening effect on radiologists and other physicians who use x rays in their practice. This effect has been at least reduced, and may have been eliminated, in recent years. An excess mortality among radiologists was shown for cancer and for other diseases. (TCO)

17572 SEMINAL PATTERNS FOLLOWING DAMAGE TO BOVINE SPERMATOGENIC EPITHELIUM. E. L. Gillette and L. A. Corwin, Jr. (Colorado State Univ., Fort Collins). J. Am. Vet. Med. Assoc., 144: 1398-1401 (June 15, 1964).

An estimation of the time periods for various segments of spermatogenesis was made by observation of changes in bull semen after x irradiation of the testicles. These time periods were compared with values reported from experiments using radioisotope labeling of spermatogonia to determine the chronologic length of spermatogenesis. The most severe alterations were observed in ejaculated semen 14 weeks after initial damage to A spermatogonia. It was estimated that, on the average, 9 weeks were required for development of spermatozoa from A spermatogonia, 3 weeks for passage of spermatozoa through the testicle, and 2 weeks for passage of spermatozoa through the epididymis. The rate and degree of recovery after this period would be due to the type and extent of original damage to the spermatogonia. Recovery from damage was practically complete by 30 weeks after irradiation. (auth)

17573 SUPPRESSION OF THE REPRODUCTIVE POTENTIAL OF THE POTATO TUBERWORM, GNORIMOSCHEMA OPERCULELLA BY GAMMA IRRADIATION. Esam Elbadry (Univ. of California, Berkeley). J. Econ. Entomol., 57: 414-15(June 1964).

Studies were made on the effects of sterile adults of Gnorimoschema operculella (Zeller) exposed to gamma radiation as fully developed pupae on the reproductive potential of normal moths when confined together in cages. The competitive ability of sterile males and females when caged with normal adults at different ratios also was tested. Irradiation of pupae was accomplished by subjecting 8-day-old male and female pupae to 15,000 and 18,000 Rads, respectively. The results showed that sterile males do not compete satisfactorily with normal individuals. The addition of sterile females to normal females at 5:1 ratio, which gave the best results, suggests the use of sterile females rather than sterile males to reduce the population of tuber moths in any autocidal control program. (P.C.H.)

17574 TRANSFER OF IMMUNITY TO SARCOMA I HOMOGRAFTS IN NEWBORN MICE. Mang-so Tsoi, Russell S. Weiser, and Seikichi Tokuda (Univ. of Washington, Seattle). J. Natl. Cancer Inst., 34: 307-17(Feb. 1965).

Immunity to Sarcoma I (Sal) was readily transferred to newborn C57BL/6Ks mice from mothers that had been either actively immunized with live tumor or passively immunized with hyperimmune serum or hyperimmune cell-free ascitic fluid containing anti-Sal antibody. The transfer of immunity to the newborn was most effectively demonstrated with a low challenge dose of 1,000 tumor cells given intraperitoneally. Foster-nursing experiments indicated that the immunity of the newborn offspring of immune mothers was acquired principally via the lacteal route. The development of Sal tumors was also prevented when the hyperimmune serum or ascitic fluid was introduced directly into newborn mice. These results indicated that acquired maternal immunity transmitted to the newborn results from humoral antibody. Adult C57BL/6Ks mice rendered immunologically incompetent by x irradiation were likewise protected by hyperimmune serum against small challenge doses of tumor cells. Serum and cell-free ascitic fluid derived from these animals during primary rejection of Sarcoma I gave much less protection to newborn mice than serum or cell-free ascitic fluid taken from hyperimmunized mice. (auth)

17575 STUDIES ON THE NUTRITIONAL VALUE OF FOODS TREATED WITH γ-RADIATION. I. EFFECTS ON SOME B-COMPLEX VITAMINS IN EGG AND WHEAT. T. S. Kennedy (Atomic Energy Research Establishment,

Harwell, Berks, Eng.). J. Sci. Food Agr., 16: 81-4(Feb. 1965).

By use of microbiological methods of assay, the effects of γ radiation at doses of 0.5 and 5.0 MRad on the content of some B-complex vitamins in frozen whole egg were studied. For comparative purposes, analyses were also performed on egg treatment by a heat-pasteurization process designed to eliminate salmonellae food-poisoning organisms. No change was apparent in pantothenic acid, biotin, and riboflavin after any of the treatments. A 24% loss of thiamine occurred at 0.5 MRad and this was increased to 61% at 5.0 MRads. Similar analyses were made on Manitoba wheat irradiated at 0.02 MRad, which is approximately the dose required for grain disinfestation, and also at ten times this dose. No apparent change was observed in the contents of nicotinic acid, thiamine, riboflavin, biotin, and total vitamin B_6 after irradiation at 0.02 MRad; pantothenic acid showed a slight loss at this dose. At 0.2 MRad a loss of 12% nicotinic acid, 11% pantothenic acid, and 10% biotin occurred. (auth)

17576 STUDIES ON THE EFFECTS OF β-RAY IRRADIATION ON THE MOLD. Tomoo Suzuki and Osamu Tanabe (Fermentation Research Inst., Chiba, Japan). Kogyu Gijutsuin, Hakko Kenkyusho Kenkyu Hokoku, No. 24, 57-67(Oct. 1963). (In Japanese)

Aspergillus awamori was irradiated with β rays and the change in the amylase activity was studied. The apparatus used for the irradiation was a Shimadzu β-ray irradiator (source $^{90}SrCl$). The doses from the apparatus were analyzed by the chemical method, and it was found that the dose at a distance of 2 cm from the source was 12.3×10^3 Rep/hr, at 5 cm 9.93×10^3 Rep/hr, and at 10 cm 4.37×10^3 Rep/hr. The spores of the aspergillus awamori var. fumeus AF-1 began to perish at 1×10^4 Rep. Fifty percent of the spores perished at $2.5 \times 10^4 \sim 4.5 \times 10^4$ Rep, and ninety percent at $7.4 \times 10^4 \sim 1.5 \times 10^5$ Rep. The amylase activity in the spores that survived was the same as the activity in the unirradiated spores. When mycelia were irradiated, no effect was observed in the growth medium at 1×10^3 Rep or less, but at 2×10^3 Rep the effect began to appear; at 6×10^4 Rep the growth stopped and the amylase activity was lost. In a resting medium, however, the damage to the mycelia was not so great as in the growing medium, and at 6×10^3 Rep no effect was observed. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964)).

17577 FUNDAMENTAL NOTIONS ON THE PARAMETERS DETERMINING THE BIOLOGICAL ACTION OF RADIATION. M. Dousset. Maroc Med., 43: 143-6(1964).

A general review of the factors bearing on biological effects of irradiation is given, including the source (external, cutaneous, or internal, routes of entry), physical energy, type of irradiation, and the tissue responsiveness. Units of measurement are defined for the delivered and absorbed dose. Dose intensity and relative biological effectiveness for different types of irradiation are discussed. Tissue sensitivity to irradiation effects is related to the metabolic activity or differentiation of the cells and the physiological age of the organism. (Excerpta Med., Sect. XXIII, 2: No. 1 (Jan. 1965))

17578 CHANGES OF THE REACTIVITY OF MICE DURING THE CHRONIC ACTION OF Sr^{90}. V. L. Shvedov and V. I. Dergachev. Med. Radiol., 10: No. 1, 30-3(Jan. 1965). (In Russian)

The alteration of the central nervous system reactions to the administration of strychnine and chloral hydrate during the chronic affection with low doses of ^{90}Sr was studied in mice. A direct relationship was established between the LD_{50} of the referred to substances and the daily quantity of the isotope introduced. In mice receiving maximal quantities of ^{90}Sr, a paradoxical reaction to the administration of pharmacological agents was observed. Interstrain and sex differences were revealed in the reactions of animals to the introduction of strychnine and chloral hydrate. (auth)

17579 THE INFLUENCE OF TRITIUM OXIDE ON THE POSTNATAL DEVELOPMENT OF RAT PROGENY. A. M. Lyaginskaya. Med. Radiol., 10: No. 1, 33-9(Jan. 1965). (In Russian)

The relation between the term of pregnancy at the time of tritium oxide administration and the peculiarities of postnatal development of rat progeny was investigated. It was found that when a similar dose of 0.3 μC/g is employed there exists no sharply pronounced relationship between these values. However, affection in the preimplantation period causes a somewhat greater intrauterine death rate of embryos, whereas affections during the fetal period produces a greater death rate of the progeny in the postnatal period of development in comparison with affection at other periods. No monstrosities in the development of the progeny were noted. (auth)

17580 THE IMPORTANCE OF CHANGES OF TISSUE HYALURONIDASE ACTIVITY IN TISSUE PERMEABILITY DISTURBANCES DURING THE ACTION OF IONIZING RADIATION. P. N. Kiselev and E. V. Karpova (Central Research Inst. of Medical Radiology, Leningrad). Med. Radiol., 10: No. 1, 54-60(Jan. 1965). (In Russian)

The altered activity of hyaluronidase and its inhibitors at different periods after whole-body x irradiation of the organism was investigated. During the first hours after irradiation in different animals there was seen a regular rise in the hyaluronidase titer in the subcutaneous connective tissue, muscles, lungs, kidneys, and blood serum. The duration of the activation period varied in different organs from 2 to 10 hours. At the end of the first 24 hours of radiation sickness the hyaluronidase titer decreased sharply; in the blood and organs there was an augmented quantity of hyaluronidase inhibitors which blocked its hydrolytic function. Activation of hyaluronidase is considered as the cause of depolymerization of tissue mucopolysaccharides and an important factor of permeability disturbance. It is suggested that an increased content of hyaluronidase inhibitors is the result of breakdown of tissue hyaluronic acid and is a compensatory reaction of the organism to arrest further desintigration of tissues. (auth)

17581 THE INFLUENCE OF EXTERNAL BETA-IRRADIATION ON THE EXCHANGE OF THIAMINE, NICOTINIC ACID AND TRANSAMINASE. M. P. Batunin, T. A. Glavinskaya, and V. S. Sakharova (Gor'kii Inst. of Medicine, USSR and Gor'kii Research Inst. of Dermatology and Venereal Disease, USSR). Med. Radiol., 10: No. 1, 62-5 (Jan. 1965). (In Russian)

The influence of external beta irradiation (radiophosphorus) on the content of vitamin B_1 (total, free, and cocarboxylase), nicotinic acid, glutamicoalanine, and glutamicoasparigine transaminases was studied in 60 experimental and 25 control guinea pigs. The blood and skin of animals were investigated 2 hours 1, 3, 7, and 14 days after a single skin irradiation in a dose of 50 R. The results were treated statistically. Local external beta irradiation caused noticeable statistically significant changes in and the balance of thiamine and nicotinic acid in the organism. They were not restricted to the irradiation field, but were also observed in intact symmetrical areas of the skin, as well as in the blood (total thiamine, cocarboxylase). During the determination of glutamicoalanine and glutamicoasparginic transaminases significant alterations were found neither in the blood, nor in the irradiated skin. (auth)

17582 THE COMBINATION OF X AND β RADIATION (^{32}P) IN MUTATION RESEARCH WITH BARLEY. Gunter W. Krausse (Universitat Halle-Wittenberg, Hohenthurm, Ger.). Naturwissenschaften, 52: 42(1965). (In German)

Karyopses of summer barley were treated with x radiation and then soaked in a ^{32}P solution. The physiological and genetic damages resulting from the single and combined applications of x and β radiations were determined. The fertility was sharply reduced in the combined treatment with respect to x-ray exposure alone. The mutation rates were determined in the X_2/β_2 or β_2/X_2 generations. The chlorophyll mutation rate in the combined series was higher than the individual series. The combined application had the highest effectivity in the mutation yield. (J.S.R.)

17583 EXPERIMENTAL STUDY OF NEUTRON-INDUCED CATARACT. I. MORPHOLOGICAL CHANGES OF CRYSTALLINE LENS OF RABBITS FOLLOWING FAST-NEUTRON IRRADIATION. Kanji Choshi (Hiroshima Univ.). Nippon Ganka Gakkai Zasshi, 67: 810-27(1963). (In Japanese)

Adult albino rabits about nine months old were exposed to fast neutrons (14.1 Mev) generated by a T-D reaction neutron generator. The rabbits were immobilized with their heads placed near the target and bodies away from it. Doses between 5×10^8 and 9.6×10^{10} n/cm^2 were used. Weekly observations were made of the lens of both eyes with an electric ophthalmoscope and slit lamp over a period of more than 21 weeks (in one case for 62 weeks). The initial lenticular changes observed in the groups exposed to less than 3.2×10^{10} n/cm^2 were small punctate dots and vacuoles in the posterior zone 17 to 53 weeks after irradiation. In the groups exposed to more than 4.8×10^{10} n/cm^2, the initial changes were small vacuoles at the anterior subcapsular region 9 to 17 weeks after irradiation. Changes in the anterior subcapsular region were noted in all cases exposed to more than 1×10^9 n/cm^2, and changes at the posterior cortex and posterior subcapsular region were noted in all exposed lenses. In the low-dose groups (5×10^8 to 2×10^9 n/cm^2), after a slight increase in opacity, the lens condition remained stationary. In the medium-dose groups (4×10^9 to 1.6×10^{10} n/cm^2), slight evidence of increase in opacity was noted and 30 to 44 weeks after irradiation subcapsular plaque-like opacities were seen at the posterior pole. In the high-dose groups (3.2×10^{10} to 9.6×10^{10} n/cm^2), an increase in opacities and a tendency of their confluence was noted at 26 to 28 weeks following exposure clusters of punctate opacities and vacuoles were observed at the cortex and subcapsular region of the posterior pole. Milder changes were noted in the contralateral eyes exposed to undetermined but smaller amounts of radiation. The observed changes in the lens resembled those of experimental radioinduced cataracts reported previously. (BBB)

17584 ELECTRICAL PROPERTIES OF ERYTHROCYTES DURING IRRADIATION. Giichi Yoshii and Machiko Miyachi (Osaka Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 1005-12(Nov. 1963). (In Japanese)

Attempts were made to obtain information on the change of the dielectric constant and conductivity of erythrocyte suspensions during exposure to ^3H_2O β rays. As one example, 1 ml of the erythrocyte suspension containing 500 mC of ^3H_2O gave a dose rate of 100 rad/min. Below 1000 rad, there were no significant changes in distribution of the size of the erythrocyte suspension during exposure. An elevation in the dielectric constant was observed from zero rad up to 1000 rad by high-frequency measurements. The elevation is considered to be due to the change in the cell membrane capacity. At low frequencies no changes were observed in the conductivity, suggesting that liberation of the ions from the cell interior to the exterior did not occur during irradiation. It was concluded that the change in the cell membrane capacity was not caused by the liberation of ions but by the polarization of the cell membrane. Irradiations at more than 1000 rad resulted in a decrease in the dielectric constant probably due to the initial radiation damage in the cell structure. The dielectric constants measured after irradiation were the same as non-irradiated, suggesting that some of the change observed during irradiation was reversible. (auth)

17585 RADIATION EFFECTS ON INTESTINAL FUNCTION. I. STUDIES ON RABBITS INTESTINAL DAMAGE BY ABDOMINAL WINDOW METHOD. Osamu Matsuoka and Takehiko Tsuchiya (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 157-62(May 1964). (In Japanese)

Rabbits with an abdominal glass window (by operation) were given x irradiation of 500–2000 R. The radiation effect on the intestines was observed through the window during 30 days after exposure and occasionally recorded photographically. It was found that there was a typical time-dependent pattern of radiation effect. The body weight of irradiated rabbits dropped after irradiation, but no diarrhea was recognized during the total period except immediately before death. The survival time for rabbits after 2000 R of abdominal irradiation is over 20 days; some survive 60 days. Symptoms observed through the window during the observation period after 2000 R were summarized as follows; during the first day after exposure there was slight hyperemia and suppression of small intestinal motility; between one and five days hyperemia of small intestine and slight hypermotility were noted; between five and fifteen days constriction of the small intestine, reduction of serosa thickness, and hemorrhage of the caecum were observed; after 15 days detachment of engorged blood vessels from the serosa, increasing constriction of the terminal ileum with interference in the movement of contents, and progressive development of ileus of the small intestine above the constricted area was noted. (auth)

17586 THEORETICAL APPROACH TO LIFE SPAN SHORTENING INDUCED BY RADIATION. 4. A MODEL FOR RADIATION INJURY. Humiaki Sato (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 211-37(June 1964).

A mathematical model for radiation injury was developed by assuming organ injury and organ-organ interaction. A normal distribution was assumed for individual fluctuation in radiosensitivity. The time-dependence of the injury was included in the model by considering retardation of transfer of the interaction. The model had a form of vector matrix. It was compared with experimental data on mode of death, recovery, LD_{50} (30) of partial-body irradiation, temporal death distribution, and so on. Some qualitative agreements could be seen in the comparison. (auth)

17587 THE INFLUENCE OF STRAIN ON SURVIVAL TIME POST 3 Kr OF X-RADIATION IN THE GERMFREE AND CONVENTIONAL MOUSE. Taiju Matsuzawa (Univ. of Notre Dame, [Ind.]). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 238-41(June 1964). (In Japanese)

Adult mice 10–11 weeks old, germfree and conventional, of four strains were irradiated with 3-kR of x rays (250 kvp, HVL 1.05 mm Cu, single, whole body exposure tissue dose 37–39 R/min). Survival times of the four germfree strains after x irradiation were compared respectively to those of four conventional strains. In general, with this dosage survival times of the germfree animals of the four strains are aproximately twice as long as those of their conventional counterparts. Survival time of germfree Swiss-Webster mice is 7.2 ± 0.37 days as compared to 3.5 ± 0.38 days of their conventional counterpart. Survival time of germfree ICR mice is 7.8 ± 0.42 days as compared to 3.9 ± 0.51 days of their conventional counterpart. Survival time of germfree CFW mice is 7.8 ± 0.41 days as compared to 3.7 ± 0.48 days of their conventional counterpart. Survival time of germfree C3H mice is 6.8 ± 0.39 days as compared to 3.2 ± 0.4 days of their conventional counterpart. (auth)

17588 THE EFFECT OF GAMMA IRRADIATION ON WHEAT GLUTEN. IV. CHANGES OF SULFHYDRYL GROUP OF WHEAT GLUTEN BY GAMMA IRRADIATION. Masao Doguchi (Tokyo-To Labs for Medical Sciences). Nippon Nogei Kagaku Kaishi, 38: 100-3(Feb. 1964). (In Japanese)

Commercial vital gluten was gamma irradiated, and the -SH contents in the gluten and acetic acid-soluble protein were determined polarographically with 0.001M $HgCl_2$. The -SH content in the gluten did not change at below 300×10^4 Rep and the value of 5.7 ~ 5.9 μequiv per gram of protein was obtained. However, irradiation with 1000×10^4 Rep increased the -SH contents to 20% higher than the control. When the extraction and titration were made at 5°C, the -SH content in the acetic acid-soluble protein was not changed at the irradiations below 300×10^4 Rep; a 40% increase from the control was observed for irradiation of 1000×10^4 Rep. When the extraction and titration were

made at room temperature, the same results were obtained for irradiations below 300×10^4 Rep, but no increase in the -SH content was observed at irradiation of 1000×10^4 Rep. It was concluded that the increase in the -SH contents caused by gamma irradiation is very unstable. As the acetic acid-soluble protein increases with increasing gamma dosage both at room temperature and at 5°C, the -SH contents per unit protein decrease. It was reconfirmed that the polarographic protein did not change, but the reason for this could not be explained by the determination of the -SH contents in the extracts. (Nucl. Sci. Abstr. Japan, 3: (Nov. 1964)).

17589 LESIONS OF THE CEREBRAL CORTEX IN RATS IN RADIATION DISEASE. PRELIMINARY REPORT. M. Ojak. Patol. Polska, 15: 239-45(1964).

A histopathologic study was carried out on the brains of 13 rats of the Wistar strain after x irradiation. Lesions were found in the nerve cells of the horn of Ammon. The character and localization of the lesions appeared to confirm the basic role of the blood circulation in the development of lesions of the nerve cells in postradiation disease. (Excerpta Med., Sect. XXIII, 2: No. 1 (Jan. 1965))

17590 ELECTRON SPIN RESONANCE OF IRRADIATED DNA. P. S. Pershan, R. G. Shulman, B. J. Wyluda, and J. Eisinger (Bell Telephone Labs., Inc., Murray Hill, N. J.). Physics, 1: 163-82(Nov.-Dec. 1964).

An electron spin resonance study of deoxyribonucleic acid (DNA) after irradiation with uv light or ionizing radiation identified the main free radical as a hydrogen addition product of the base thymine. The unpaired spin was located at the C_5 position from its hyperfine interaction of 20.8 ± 0.3 gauss with the $-CH_3$ group attached to C_5 and confirmed by deuteration of the methyl group. Hydrogen atom addition at the C_6 was proven by exposing the DNA to D_2O vapors before irradiation in which case the 37.76 hfs of the CH_2 was reduced to the value characteristic of CHD. The amount of water vapor increased the amount of thymine radical as did increasing the intensity of irradiation and the sample temperature during irradiation from 77 to 195°K. The quantum yield was $\sim 5 \times 10^{-4}$ radicals/photon adsorbed which, within experimental error, is as large as for any stable photoproduct of DNA. Paramagnetic metal ions bound to the DNA in the ratio of one per ten phosphates reduced the amount of free radical formed by a factor of about six. Denaturing the DNA does not change the resonances observed. DNA from different animals shows different amounts of the thymine radical and these differences are not understood. It is not known what stable photoproduct is formed by the thymine radical when it disappears at room temperature in moist samples. Four other radicals are characterized, but not identified, by subtracting the calculated thymine spectrum from the observed spectra. (auth)

17591 HAEMODYNAMIC CHANGES IN PATIENTS WITH HYPERTHYROIDISM AND POLYCYTHAEMIA VERA TREATED WITH RADIOACTIVE ISOTOPES. J. Hasik (Poznan Society of Friends of Science, Poland). Poznan Towarz. Przyjaciol Nauk, Wydzial Lekar., Prace Komisji Med. Doswiadczalnej, 28: 103-45(1964).

Hemodynamic studies were carried out on 55 patients with hyperthyroidism prior to treatment, on 60 patients with hyperthyroidism following treatment by radioactive iodine ^{131}I, on 10 patients with ^{131}I induced hypothyroidism, on 25 patients with erythremia prior to treatment, and on 12 such patients after treatment with radioactive phosphorus. For comparison 12 subjects with primary hypothyroidism and 40 healthy subjects aged from 20 to 30 were also included. Studies were made on: physical analysis of circulation according to Bremser-Ranke; assessment of the dynamics of left ventricle contraction after Blumberger; and ECG and BCG. Two correction factors were applied on the physical analysis of circulation in erythremia patients: blood viscosity factor of 1.063; and factor of 20% for the widening of transversal diameter of aorta. Special attention was paid to the qualitative appearance of arterial sphygmogram, which was found to be of value in following the effect of therapy. The studies on pulse wave velocity suggested that an increase in pulse wave velocity does not indicate an alteration pathognomonic of atherosclerosis, the deficiency in arterial wall elasticity being rather due to metabolic and neurogenic factors. ^{131}I-therapy of hyperthyroidism prevented the patients from circulatory failure by reducing cardiac stroke volume, cardiac output, and heart work. The isometric phase of cardiac contraction is prolonged to upper normal limits. The morphology of BCG becomes improved and normalization of time ratios in relation to ECG is evident. The same holds true for the time duration of particular segments of the BCG-curve, The pulse wave velocity increased up to normal values. The percentage of patients without pathological ECG findings was raised. The treatment of erythremia patients with ^{32}P caused an overload of the circulatory system by reducing cardiac stroke volume, cardiac output, and heart work to normal range. The pulse wave velocity and arterial elastic resistance were also decreased. The isometric phase of left ventricle contraction was shortened. The time duration of some BCG segments previously increased returned to normal. ECG changes became partially reversed qualitatively and quantitatively. (Excerpta Med., Sect. XXIII, 2: No. 2(Feb. 1965))

17592 AMNIOTIC FLUID MEASUREMENT IN CORTISONE TREATED AND X-IRRADIATED MICE. Bruce E. Walker (Univ. of Texas, Galveston). Proc. Soc. Exptl. Biol. Med., 118: 606-9(Mar. 1965).

The amount of amniotic fluid associated with mouse embryos at the normal time for palate closure was determined in cortisone treated, x irradiated, and control embryos. Both of these cleft palate-inducing teratogens caused a significant reduction in amount of amniotic fluid. However, a few embryos destined to have cleft palate had as much amniotic fluid as most normal embryos, and a few normal embryos had as little amniotic fluid as most treated embryos. Therefore, the reduction in amniotic fluid caused by these teratogens is not the effect that is primarily responsible for development of the cleft palates. (auth)

17593 TRANSPLANT IMMUNITY TO POLYOMA VIRUS INDUCED TUMORS. III. EVIDENCE FOR HETEROGENEITY AMONG TRANSPLANT ANTIGENS IN VIVO. J. Donald Hare and Tore Godal (Univ. of Rochester, N. Y.). Proc. Soc. Exptl. Biol. Med., 118: 632-6(Mar. 1965).

The ability of 2 polyoma virus strains, 3049 and lp-D, to produce transplant immunity in adult hamsters against tumor cells induced by both strains was studied. The 3049 virus immunized hamsters against tumor cells produced by itself, but tended to enhance the growth of lp-D virus-induced tumor cells. On the other hand, the lp-D virus produced little or no immunity against its own tumor cell, but enhanced the growth of 3049 virus-induced cells. X-irradiated tumor cells induced by the 3049 virus, when given to adult hamsters, enhanced the growth of both 3049 and lp-D tumors. Possible explanations for these paradoxical results, based on the presence of at least 2 transplant antigens, are discussed. (auth)

17594 EFFECTS OF X-IRRADIATION ON SUSCEPTIBILITY OF NEONATAL RAT BRAIN AND MUSCLE TO COXSACKIE B1 VIRUS INFECTION. Larry Schneck and Sumner Berkovich (State Univ. of New York, Brooklyn). Proc. Soc. Exptl. Biol. Med., 118: 658-61(Mar. 1965).

Large doses of x irradiation primarily to the head of the newborn rat 24 hours prior to infection with Coxsackie B1 virus resulted in an immediate increase in the titer of virus recovered from brain. Six days later a delayed rise was also detected in skeletal muscle harvested from a site distant from the point of maximum irradiation. In brain the increased viral yield was probably related to the simultaneous effects of ionizing radiation on both the head and the body. There is no satisfactory explanation for the delayed effect noted in muscle. (auth)

17595 HISTOENZYMIC RESEARCHES ON THE BEHAVIOR OF ENZYMES OF THE ADRENALS OF GUINEA PIGS AFTER LOCAL AND WHOLE-BODY X-RAYING. Jan Jonek, Henryk Grzybek, and Teresa Jonek (Medical Acad-

emy, Zabrze, Poland). Protoplasma, 58: 391-401(1964). (In German)

Whole-body or local irradiation with 400 R x rays was applied to 24 guinea pigs, with 12 unirradiated controls. At various intervals enzymes were demonstrated in different zones of slices of the adrenal glands. At 24 hr after whole-body irradiation there was an increase, but after 4 days a decrease of respiratory enzymes. After 11 days the animals showed appreciable individual variations in enzymes. Alkaline phosphatase (I) and adenosinetriphosphatase (II) increased in the first few days after irradiation but later decreased. After local irradiation there was an increase in I, II, and reduced diphosphopyridine nucleotide diaphorase and a decreased activity of succinic dehydrogenase. The changes appeared to result from a stress reaction acting on the adrenals and resulting in part from factors outside the adrenals, such as protein fission and disruption of electrolyte balance throughout the body. The results are interpreted in relation to previous results. (auth)

17596 PREVENTION OF REPAIR IN IRRADIATED RHIZOPUS STOLONIFER SPORANGIOSPORES BY INHIBITORS OF PROTEIN SYNTHESIS. N. F. Sommer, J. H. Goertz, and E. C. Maxie (Univ. of California, Davis). Radiation Res., 24: 390-7(Mar. 1965).

Experiments with nongerminating sporangiospores of Rhizopus stolonifer demonstrated that chloramphenicol or other inhibitors of protein synthesis reduce or prevent repair of potentially lethal irradiation lesions. These data contrast with some previous reports of enhanced colony formation resulting from postirradiation treatment with chloramphenicol. Possibly the effect of protein inhibitors depends on the experimental conditions. If growth is not otherwise inhibited, protein inhibitors may slow growth more than repair processes to provide a net effect favoring recovery. If germination or growth is prevented by other means, only a reduction in repair would be expected to result from the presence of a protein inhibitor. (auth)

17597 ACCELERATED SENESCENT CHANGES IN ADRENAL CORTEX OF THE HAMSTER. F. M. Sahinen and A. L. Soderwall (Univ. of Oregon, Eugene). Radiation Res., 24: 412-22(Mar. 1965).

Ninety-one multiparous female hamsters were divided into six experimental and one control groups and treated with either single or repetitive doses of 25, 50, or 100 R of filtered x irradiation. At 14 months of age, the animals were sacrificed, and the adrenal cortex was examined histologically for evidence of change. The lower x irradiation groups, both single and repetitive, showed a change comparable to that seen in aged animals. The 100-R single-dose animals exhibited a greater degree of change, whereas the 100-R animals that received three successive doses appeared extensively affected. The changes, which progressively intensified with increased dosage, included: the development of hyperplastic nodules in the subcapsular and supracapsular area, increased deposition of lipofuscin, marked vacuolation, both intercellular and intracellular, and an increased number of cysts. All changes observed had previously been described as components of natural aging in the hamster. This lends some credence to the hypothesis that radiation damage mimics aging. (auth)

17598 FURTHER STUDIES OF X-RAY CONDITIONED SACCHARIN AVERSION DURING THE POSTEXPOSURE PERIOD. James C. Smith, Henry L. Taylor, Dale D. Morris, and Jean Hendricks (Florida State Univ., Tallahassee). Radiation Res., 24: 423-31(Mar. 1965).

Albino rats receiving saccharin solution, water, or an empty bottle prior to irradiation were given a saccharin-water preference test either immediately after exposure or after a 24-hour delay. It was found that all animals getting the immediate preference test avoided the saccharin solution during the preference test. For animals receiving the delayed test, only those that drank saccharin prior to x ray exposure demonstrated the saccharin aversion during the preference test. The results of the immediate groups were interpreted as conditioning, since the saccharin solution was available immediately after exposure during a period that has previously been described as critical for production of saccharin aversion. (auth)

17599 A SARCOMA OBSERVED IN THE IRRADIATED MONKEY. Joseph M. Gowgiel (Univ. of Chicago). Radiation Res., 24: 446-51(Mar. 1965).

A fibrosarcoma developed in the left mandible of a Macaca rhesus monkey 25 months after receiving 7500 R of external fractionated x irradiation. The animal was about 28 months old at the time of irradiation and was the only one of fourteen irradiated monkeys to develop a malignancy. The tumor is suspected to have arisen at the juction of irradiated and nonirradiated tissue. (auth)

17600 RESPONSES OF X-IRRADIATED DOGS TO INDUCED MUSCULAR CONTRACTION IN VIVO. Ching-tong Liu and R. R. Overman (Univ. of Tennessee, Memphis). Radiation Res., 24: 452-72(Mar. 1965).

Certain physiological responses of normal and x irradiated dogs to protracted, induced muscular contraction were studied in vivo. The experimental animals were given a single whole-body x irradiation exposure of 700 or 800 R, and the increased muscular activity was induced 3 to 4 days postirradiation. The induced muscular contraction was performed in supine, anesthetized dogs by the electrical stimulation of the sectioned sciatic nerve with a frequency of 95 pulses per minute. The intensity of stimulus was 50 volts, and its duration was 60 msec. The movement of the contracting leg was against a 300-gm weight. Both normal and x irradiated animals demonstrated that the muscular work was decreased approximately 45% after the first hour from its initial value and then remained at a relatively constant level throughout the experiment. During muscular activity, blood flow to the contracting muscle was greater in the 700-R group than in the normal animals. Although the change in oxygen consumption followed almost the same pattern as blood flow, no difference was found between these two groups. Similar responses of normal and x irradiated animals to induced muscular contraction demonstrated that the glycogen content of the stimulated muscle was reduced and the venous blood hematocrit was increased. Several differences between the two groups of animals due to induced muscular contraction were observed. (P.C.H.)

17601 RADIATION RESPONSES OF HEMOPOIETIC COLONY-FORMING CELLS DERIVED FROM DIFFERENT SOURCES. L. Siminovitch, J. E. Till, and E. A. McCulloch (Univ. of Toronto and Ontario Cancer Inst., Toronto). Radiation Res., 24: 482-93(Mar. 1965).

Hemopoietic colony-forming cells derived from adult femoral marrow, adult spleen, and fetal liver did not exhibit a uniform sensitivity to radiation when freshly explanted cells from these sources were tested in the same way for the survival of colony-forming ability after irradiation in vivo. The D_0 values and extrapolation numbers observed were: for adult femoral marrow, 95 ± 9 Rads, 1.50 ± 0.54; for adult spleen, 90 ± 16 Rads, 0.80 ± 0.46; for fetal liver, 146 ± 26 Rads, 1.08 ± 0.50. Fourteen days after transplantation into x irradiated (900 Rads) hosts, hemopoietic colony-forming cells derived from femoral marrow, spleen, or fetal liver showed a relatively uniform, increased radiosensitivity for cells proliferating in spleen or in marrow. The D_0 values and extrapolation numbers for cells proliferating in spleen were found to be: for cells derived originally from marrow, 69 ± 12 Rads, 0.99 ± 0.42 for cells derived from spleen, 74 ± 15 Rads, 0.77 ± 0.43; for cells derived from fetal liver, 80 ± 16 Rads, 0.72 ± 0.42. For cells derived from fetal liver, the increase in radiation response took place during the first 6 days after transplantation of the cells into irradiated hosts. (auth)

17602 THE REVERSIBLE DEPRESSION OF BACTERIAL LUMINESCENCE DURING EXPOSURE TO X-RADIATION. C. H. Burns, A. P. Jacobson, and G. H. Whipple (Univ. of Michigan, Ann Arbor). Radiation Res., 24: 494-502(Mar. 1965).

The rate of the in vitro steady-state bacterial luciferase reaction, as measured by the intensity of the luminescence it produces, has been shown to be reversibly depressed while being exposed to x radiation in the dose-rate range

10 to 100 Rads/sec. Depression of luminous intensity occurs promptly on exposure and reaches a new steady state the level of which is inversely related to dose rate. Recovery of the original luminous intensity begins immediately at the end of the exposure and is complete. These observations require that the radio-sensitive component be one that is continuously generated by the system. An analysis of the behavior of luminescence suggests that this component is most likely reduced flavin mononucleotide ($FMNH_2$), which is generated by the NADH–oxidase system, also present. Similar results were obtained when luminescing intact cell suspensions were subjected to the same exposure, except that recovery was not complete. The fact that the effect of radiation on the luciferase reaction is instantaneous, whether the reaction takes place in vitro or in vivo, presents the possibility that a primary biochemical effect of radiation in animal tissues may be the temporary depression of metabolic processes catalyzed by enzymes requiring flavins as prosthetic groups. (auth)

17603 EXTREME SENSITIVITY TO LOW-LEVEL X-RAYS IN THE EYE OF THE COCKROACH BLABERUS. W. F. Baldwin and J. B. Sutherland (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiation Res., 24: 513-18 (Mar. 1965).

Electroretinograms were induced in the compound eyes of Blaberus giganteus by x rays. The response increased with dark adaptation, an effect that appeared to be associated with the migration of eye pigments. The magnitude of the response depended on the total dose of x rays over the range from 0.09 to 22.4 MR and was independent of dose rate from 1.2 to 41 R min. The reaction in the ommatidia appeared to be stimulated by single photons. Thus, a refinement of techniques for the measurement of ERG's from single ommatidia may permit the detection of a response at even smaller doses. (auth)

17604 EFFECT OF X-IRRADIATION ON HISTIDINE DECARBOXYLASE OF RAT STOMACH. Yutaka Kobayashi (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). Radiation Res., 24: 503-12(Mar. 1965).

When normal rats were given 2000 R of whole-body x irradiation, the stomach histidine decarboxylase was found to drop to 25% of its normal value within 24 hours postirradiation. Fasted rats exposed to similar irradiation showed no change in histidine decarboxylase levels after irradiation. Since the normal fasting level of rat stomach histidine decarboxylase was found to be approximately 25% of the normally fed level, it was not determined from these observations whether the fall in the histidine decarboxylase activity of fed irradiated rats was due primarily to radiation or to anorexia. When the stomach tissues from normal and x irradiated rats were fractionated and compared for histidine decarboxylase activity, the x irradiated group showed a large increase in enzyme activity in the insoluble debris fraction when compared to the controls. It is suggested that the irradiation may have altered the solubility characteristic of histidine decarboxylase. (auth)

17605 MODERN PROBLEMS IN RADIATION GENETICS. N. P. Dubinin. Radiobiologiya, 4: 801-3(1964). (In Russian)

The basic problems in modern radiation genetics requiring study are listed as: the primary mechanism of radiation action on the chromosome and molecular levels; protection of the hereditary structures in the cell from radiation damage; and the remote genetic effects on the population of organisms and cells in the organisms. The numerous factors accessory to these three phases of study are also discussed. (IIC-M.G.)

17606 ON THE MUTAGENIC EFFECTIVENESS OF INCORPORATED ^{14}C. A. M. Kuzin, Ya. L. Glembotskii, Yu. A. Lapkin, G. S. Kalendo, Yu. I. Bregadze, Ya. V. Mamul, and E. N. Myasnyankina. Radiobiologiya, 4: 804-9(1964). (In Russian)

Incorporated ^{14}C had a dose-dependent mutagenic effect in Drosophila melanogaster, from 444 to 610 sex-linked recessive lethal mutations for 1 Rad per 10^7 gametes. A 2.7-fold increase in the dose increased the percentage of mutations 3.5-fold. Gamma irradiation of the eggs, larvae, and pupae caused from 192 to 264 lethals, averaging 207, per Rad/10^7 gametes. In adult males the figure was 162 per Rad/10^7 gametes. The ^{14}C effect was 2.5 times that of chronic external gamma irradiation from ^{60}Co. Chronic gamma irradiation at all stages of development was 20% more effective than that of adult males. (tr-auth)

17607 GENETIC EFFECTIVENESS OF DIFFERENT KINDS OF IONIZING RADIATION. M. D. Pomerantseva. Radiobiologiya, 4: 810-17(1964). (In Russian)

Based on the frequency of dominant lethal mutations produced in mature sperm and damage to testicles, fast neutrons were 5–6 times more effective than ^{60}Co gamma irradiation and 4 times more so than x rays. Protons with 660 Mev energy were approximately twice as effective as x rays, and the RBE of protons was 0.6–0.7 times that of ^{60}Co gamma irradiation. The RBE of ^{60}Co γ irradiation was 0.6–0.7 that of 190-kv x rays. In the dose range studied, with all types of radiation the effects used as criterions were approximately exponential functions of the dose. Spermatids were 2.5 times more radiosensitive than sperm to protons and γ rays and 1.8 times more to fast neutrons; the RBE of neutrons was somewhat lower for spermatids. The ratio of mutations causing death of the embryo before and after implantation was approximately the same for all types of radiation. The RBE of fast neutrons based on the criterions mentioned was greater than that based on the symptoms of radiation sickness, but for protons and γ rays it was of the same order. (tr-auth)

17608 THE DURATION OF NUCLEUS CYCLE OF MARROW CELLS OF IRRADIATED MONKEYS. L. P. Kosichenko and M. S. Bystrovzorova. Radiobiologiya, 4: 818-21(1964). (In Russian)

Bone marrow cells of 3- to 5-year-old monkeys (Macaca mulatta) showed 9% chromosome rearrangements 1 hr after a 50-R whole-body irradiation dose compared to 0.8% in controls. The value dropped to 6% at 10 hr, rose to 10% at 15 hr, and then gradually dropped to 2% at 40 hr. The types of fragments at times from 1 to 40 hr are tabulated. From 1 to 40 hr the percentage of chromatid bridges decreased, while that of chromosome bridges increased. (IIC-M.G.)

17609 CYTOGENETIC RADIOSENSITIVITY OF VARIOUS PHASES OF MOUSE EMBRYONIC TISSUE CELL CYCLE. Z. A. Dznemilev and L. D. Perepelkina. Radiobiologiya, 4: 822-7(1964). (In Russian)

Cultures of embryonic mouse cells x irradiated to 50 R showed 23% chromosome breakage 2 hr later. The figure dropped to 10% at the 4th hr where it stayed until the 12th hr, then rose to 23% at the 14th hr, finally starting to drop at 18 hr acid reaching about 5% at 70 hr. The types of chromosome rearrangement and conditions in different phases of the mitotic cycle were analyzed. (IIC-M.G.)

17610 RADIATION ANALYSIS OF THE STRUCTURE AND REPRODUCTION OF CHROMOSOMES. B. N. Sidorov and N. N. Sokolov. Radiobiologiya, 4: 828-35(1964). (In Russian)

The structure and reproduction of chromosomes were studied by observing the x-ray-induced (400 R) rearrangements in Crepis capillaris seedlings. Observations showed that chromosomes consist of two strands that can reproduce and combine independently. Finer substrands were not seen. Each thread is a matrix and forms new threads by a conservative reproduction method. Probably the matrix itself at the subbiological level has a complex structure. If the diameter of the chromatid consists of many DNA molecules, a single thread of all molecules is in one polychromatid and their complementary homologs in the second. The results indicated a lack of dependence of the polyconservative method of chromosome reproduction on the centromere since the acentric fragments reproduce the same way as the centric. (IIC-M.G.)

17611 NUCLEUS CHANGES IN THE CULTURE OF EMBRYO CELLS OF MAN AFTER GAMMA-IRRADIATION

WITH THE DOSES OF 5-20 r. V. M. Kozlov. Radiobiologiya, 4: 840-2(1964). (In Russian)

The length of the mitosis cycle in human tissue cultures was not changed by 5 to 20 R irradiation. Cells were most radiosensitive in the synthesis phase. In the rearrangements caused by irradiation, only the fraction of chromatid bridges with a single fragment changed. The dose that doubles the mutation frequency is 8.0 R, but may be less under some conditions. (tr-auth)

17612 ON THE POSSIBILITY OF REMOTE MUTAGENIC ACTION OF IONIZING RADIATION ON MAMMALS. Yu. Ya. Kerkis, A. G. Sverdlov, L. N. Yasnova, and A. V. Urzhenko. Radiobiologiya, 4: 847-53(1964). (In Russian)

In 2- to 3-month-old mice irradiated to 1500 R with the heads screened, the frequency of chromosome breakage in the corneal epithelium was 7 times that in animals completely shielded with lead and 10 times that in unirradiated controls. The results indicate formation of mutagenic factors that are transported in the organisms. (IIC-M.G.)

17613 ON THE STUDY OF COMBINED ACTION OF MUTAGENIC SUBSTANCES AND UV-RAYS ON THE APPEARANCE OF INVERSE MUTATIONS IN E. COLI 113-3. Z. I. Bandura, E. N. Voronina, A. S. Poslovina, N. M. Groyukhova, and R. I. Salganik. Radiobiologiya, 4: 865-70(1964). (In Russian)

The combined action of uv irradiation with formaldehyde increased the number of reverse mutations in the auxotrophic E. coli B_{12}^{-} 2 to 5 times over the total mutagenic effect of each factor used alone. Under similar conditions, hydroxylamine decreased the mutagenic action of uv rays, although in the absence of radiation it showed definite mutagenic properties. The combined action of uv irradiation and chemical mutagens is considered to be basically a denaturation of DNA by the uv radiation, which increases the reaction capacity of the nitrogen bases in the DNA. (tr-auth)

17614 REGULARITY OF DISTRIBUTION OF CREPIS CAPILLARIS CHROMOSOME BREAKAGE IN DIFFERENT TYPES OF ABERRATIONS UNDER THE INFLUENCE OF X-RAYS AND ETHYLENIMINE. V. V. Shevchenko. Radiobiologiya, 4: 870-8(1964). (In Russian)

No difference was observed in the reaction of different parts of x irradiated C. capillaris chromosomes in G_1 and G_2. Localization of chromosome breakage after treatment with ethylenimine was very specific in certain portions. In C. capillaris there was no correlation between high frequency of breakage and distribution of heterochromatin, as was observed in V. fabia. There was a high correlation between localized interstitial deletions in D chromosome 1–1.5 μ from the centromer. Both with x irradiation and ethylenimine administration, the frequency of breakage increased at the distal ends of the chromosome in the chromatid translocations, by comparison with the deletions. A difference in ability to reunite and excessive union proximal and distal ends may be assumed. Small differences in localization of breakage, observed in analysis of deletions and translocations, did not affect the specific action of ethylenimine in relation to x rays. (IIC-M.G.)

17615 INFLUENCE OF UV RAYS ON CHLORELLA. I. D. Anikeeva, E. N. Vaulina, and V. A. Shevchenko. Radiobiologiya, 4: 883-93(1964). (In Russian)

Experiments showed that strains of Chlorella differed in sensitivity to uv radiation; the dose dependency was sigmoid. The frequency of mutations in one strain increased with dose to a maximum value and then decreased. When a series of generations was irradiated all the growth dynamics of the population changed. (tr-auth)

17616 SOME PHYSICO-CHEMICAL DATA ON INTERCHANGE OF GASES IN MUSCA DOMESTICA L AND NUCLEONIC DNA COMPOSITION OF THEIR GRUBS (L_{III}) IN THE FIRST GENERATION INDUCED BY INTERNAL ^{32}P BETA-IRRADIATION. V. P. Harlamov. Radiobiologiya, 4: 893-6(1964). (In Russian)

A ^{32}P dose of 0.2 μC/g increased and 20 μC/g decreased gaseous exchange in the fly Musca domestica L. The maximum dose used (20 μC/g) did not affect the nucleotide composition of DNA of the first-generation larvae. (tr-auth)

17617 RADIATION INFLUENCE ON THE DEVELOPMENT OF LACTIC GLANDS OF PREGNANT MICE. I. V. Shiffer. Radiobiologiya, 4: 896-903(1964). (In Russian)

In mice, the relative volumes of fatty and glandular tissue in the mammary gland changed during pregnancy and after parturition. Local x irradiation of 500, 1000, and 2000 R suppressed growth of glandular tissue, which developed during pregnancy. The amount of suppression was a direct function of the dose. When conception occurred up to 15 days after the irradiation, gland growth was significantly suppressed. The effect was much less when conception occurred 30–90 days later. Comparison of data obtained with those in the literature indicated that the rate of tissue recovery depends on the rate of the proliferation process. The increase in proliferation activity of the irradiated mammary gland resulting from folliculin injection resulted in an increased repair process. (tr-auth)

17618 REMOTE AFTER-EFFECTS OF IRRADIATION ON HIGH PARTS OF CENTRAL NERVOUS SYSTEM OF RATS IRRADIATED DURING PRENATAL DEVELOPMENT. I. A. Piontkovskii and M. B. Goldberg. Radiobiologiya, 4: 904-11(1964). (In Russian)

Adult rats that were x irradiated to 50 or 150 R as 14-day embryos showed cerebral cortex function damage. The deterioration was apparent as early as 2 months after birth and progressed with time. The conditioned reflex to both light and sound was damaged; the deterioration in the light reflex was observed first, but that in the sound reflex was greater. Data are presented for both irradiation levels and controls of animals 2-8 and 24-26 months old. (IIC-M.G.)

17619 REMOTE CHANGES IN NERVOUS ACTIVITY OF RATS IRRADIATED MANY TIMES DURING THE PERIOD OF PRENATAL DEVELOPMENT. V. N. Semagin. Radiobiologiya, 4: 911-15(1964). (In Russian)

The attenuation of stimulating and retarding processes resulting from numerous prenatal x irradiations of the rats was lifelong. The difference between the higher nerve action in irradiated rats and the controls increased with age. (tr-auth)

17620 MICRO-EXAMINATION OF RADIATION DAMAGES IN MARROW CELL CULTURE WITH THE HELP OF LUMINESCENCE. V. G. Kondratenko. Radiobiologiya, 4: 916-21(1964). (In Russian)

Bone marrow cells in cultures were found to be highly sensitive to ionizing radiation. Supravital studies by phase contrast and luminescent microscopy of physico-chemical and structural changes in the nucleus and cytoplasm immediately after irradiation showed differences in the reactions of radiation-sensitive and -resistant cells. Destruction of the nuclear DNA proteins started earlier and were more definite in the former. For equal radiation doses, functional and structural changes in the cytoplasm and myeloid cells occurred much earlier and were more extensive than in fibroblast and amniotic epithelium cultures. (tr-auth)

17621 HEREDITARY CHANGES IN WINTER WHEAT INDUCED BY GAMMA IRRADIATION. S. I. Makarova. Radiobiologiya, 4: 924-6(1964). (In Russian)

Mutations in the M_2 descendants of wheat seeds irradiated in the dry state to 10 and 15 kR (^{60}Co) differed for different strains. One strain completely winter-killed even in a good winter, while one strain showed promise warranting further development. (IIC-M.G.)

17622 OXYGEN EFFECT IN X- AND GAMMA-IRRADIATION OF GRAIN BEETLES. I. B. Bychkovskaya and G. K. Ochinskaya. Radiobiologiya, 4: 928-9(1964). (In Russian)

X and gamma irradiation of grain beetles in the presence of a normal amount of oxygen resulted in almost the same mortality. In the absence of oxygen, mortality was lower for both, the decrease being greater for gamma irradiation. (IIC-M.G.)

17623 CHANGE OF SENSITIVITY TO UV-RAYS AND REACTIVITY IN RESTING YEAST CELLS. E. N. Kabakov and N. M. Kabakova. Radiobiologiya, 4: 929-31(1964). (In Russian)

Saccharomyces vini cells held 24 hr at 30°C in a nonnutrient medium had higher resistance to uv irradiation than controls. Results were similar at 30°C in a thermostat and at 4°C in apparatus that was aerated for stirring, but the rate of decrease in sensitivity was slower in the first case (48-72 hr) than in the second (24 hr). No effect was observed after 72-96 hr at 4°C. The effect is considered due to a change in ability of the cells to be reactivated after the irradiation. This was verified by experiments on photo- and dark-reactivation; The aerated cells showed the highest rate of loss of ability to be photoreactivated. (IIC-M.G.)

17624 RADIATION AFTEREFFECTS ON BAC. MEGATERIUM SPORES. Zh. Safiyazov and L. H. Eidus (Inst. of Microbiology, Academy of Sciences, USSR and Inst. of Biological Physics, Moscow). Radiobiologiya, 5: 32-4 (1965). (In Russian)

Postirradiation heat treatment of dormant spores of microorganisms decreased their survival rate as a result of hidden damage. (tr-auth)

17625 EFFECTS OF IONIZING RADIATION ON METABOLISM OF PHENOL COMPOUNDS IN PLANTS. A. M. Kuzin, V. A. Kopylov, and S. K. Melnikova (Inst. of Biological Physics, Moscow). Radiobiologiya, 5: 35-9(1965). (In Russian)

Gamma irradiation, 15 kR, of the peripheral layer of potato tubers increased the ortho-phenol content 44%. The chlorogenic and caffeic acids, separated chromatographically, were found to have increased 50 and 70%, respectively. The high caffeic acid may be partially responsible for the decrease in seed development observed earlier with extracts from irradiated tubers. An earlier hypothesis concerning the participation of ortho-phenol and ortho-quinone in the formation of radiation toxins in irradiated plant tissue was verified. (tr-auth)

17626 DYNAMICS OF ADENOSINE-TRIPHOSPHORIC ACID CONTENT IN ORGANS AND TISSUES OF WHITE RATS DURING RADIATION SYNDROME. V. N. Totskii (Pirogov Inst. of Medicine, Odessa). Radiobiologiya, 5: 40-3(1965). (In Russian)

A total x irradiation of 600 R in white rats decreased the ATP in almost all organs and tissues, the changes being greatest in the spleen, liver, small intestine, and stomach. The ATP returned to normal levels in these organs only after several months. The amount of ATP was also significantly charged in relatively radiation-resistant organs: brain, heart muscle, and skeletal muscle. (tr-auth)

17627 EFFECT OF WHOLE-BODY X-IRRADIATION INFLUENCE ON CONJUGATE OXIDATIVE PHOSPHORYLATION AND MECHANISMS OF ITS REGULATION IN RAT LIVER MITOCHONDRIA. K. P. Hanson (Central Research Inst. of Roentgen-Radiology, Leningrad). Radiobiologiya, 5: 44-8(1965). (In Russian)

Twenty-four hours after 800 R whole body irradiation, the conjugated oxidative phosphorylation processes in mitochondria separated from rat liver were disrupted. The P/O ratio decreased as a result of a decrease in the inclusion of inorganic phosphate in organic phosphorus compounds. Oxygen absorption did not change. The degree of damage differed for different substrates. Ascorbic acid was oxidized at the lowest P/O ratios while phosphorylation, which is related to oxidation of succinic acid, did not decrease. (tr-auth)

17628 INVESTIGATIONS OF MECHANISMS OF RADIATION EFFECTS ON LIVING OBJECTS BY MEANS OF KINETICS OF REPARATION PROCESSES. V. I. Suslikov (Inst. of Biological Physics, Moscow). Radiobiologiya, 5: 49-56(1965). (In Russian)

Correlation and reparation criteria were formulated, from literature data, for use as first approximations in evaluating the specific contribution of various radioinduced changes in the final post-irradiation biological picture. The criteria may also be used to indicate the place of radioinduced changes in the damage syndrome. The possibility of a new way to look for means of protecting from lethal chronic and occasional irradiation is shown. (tr-auth)

17629 X-IRRADIATION INFLUENCE ON IN VITRO ERYTHROPOIETIC BLOOD ACTIVITY IN ANEMIA ANIMALS. R. A. Arutyunyan (Inst. of Physiology, Leningrad and Dept. of Biology, Academy of Medical Sciences, Erevan). Radiobiologiya, 5: 77-80(1965). (In Russian)

The blood of anemic animals had a high erythropoietic activity. Treatment of fasting rabbits with nonprotein plasma extracts from these animals caused a significant increase in erythropoiesis. X irradiation in vitro to 5 kR had no depressing effects on the erythrocyte activity in the blood of anemic animals. (tr-auth)

17630 IMMUNITY EFFECTS IN RABBITS X IRRADIATED AFTER REPEATED INJECTION OF ANTIGENS. I. INVESTIGATION OF THE DYNAMICS OF THE APPEARANCE AND MORPHOLOGY OF CELLS CONTAINING ANTIBODIES BY THE "INDIRECT METHOD" OF KUNS. K. A. Lebedev (Gamalin Inst. of Epidemology and Microbiology, Moscow). Radiobiologiya, 5: 81-6(1965). (In Russian)

X irradiation 1, 2, and 4 days after repeated immunization of rabbits with diptheria antitoxin did not cause a further decrease in the number of cells that formed antibodies. Antibodies were synthesized in many cells that existed significantly longer than in the nonirradiated immunized rabbits. In the first few days after irradiation there was a somewhat lower percentage of young cells containing antibodies. Eight to 14 days after immunization there was a significantly larger number of antibody-containing cells than in unirradiated controls. After irradiation, antibody synthesis took place in the same type of cells as in nonirradiated animals, but in a high percentage of cells there were degenerative changes in the nuclei and protoplasm as well as differences in the amount and localization of the antibodies. The percentage of lymphocyte-like cells was high. When the irradiation took place in the induction and early antibody synthesis phases, a distinct clonal distribution of cells containing antibody was noted in the lymph nodes. (tr-auth)

17631 RADIATION CANCER OF THE SKIN. George T. Pack and Jeff Davis (Pack Medical Foundation, New York). Radiology, 84: 436-42(Mar. 1965).

Examples (59) of roentgen and radium carcinoma of the skin resulting from post-irradiation dermatitis are reported. The major number of cutaneous radiation carcinomas occur in patients from the fifth to the seventh decade of life. The average age ranges from 43 to 49 years. The majority of radiation cancers occur in the skin of males because of their greater frequency of occupational exposure. In the series of 59 patients, 17 were females. 39 of the patients had cancer on the hands. The sites of radiation carcinomas incidental to occupational exposure are determined by the areas of exposure. Treatment and prevention of radiation cancer of the skin are discussed. (P.C.H.)

17632 FRACTIONATION IN PREOPERATIVE IRRADIATION. Bernard H. Feder (Veterans Administration Hospital, Long Beach, Calif. and University of California at Los Angeles). Phyllis B. Blair, and Perry Close. Radiology, 84: 447-51(Mar. 1965).

An investigation was made and certain basic principles were established using a solid tumor model. Mice were exposed to 2000, 3500, or 5000 R and then received transplantable C3H rhabdomyosarcomas. The results showed that large total doses of 5000 or 35000 R given in single or large fractions effectively inhibited transplantability. Division of the total doses into smaller fractions reduced their effectiveness. A small dose (2000 R) given in single or large fractions inhibited transplantability to a lesser degree. Moreover, division of the total dose into smaller

fractions eliminated its effectiveness almost entirely. It was concluded that at low dose levels, preoperative irradiation may be more effective if relatively little fractionation is used. (P.C.H.)

17633 EFFECTS OF IODOACETIC ACID AND X RAYS ON THE INCORPORATION OF THYMIDINE ^{3}H AND LABELED PHOSPHORUS INTO DNA OF RAT THYMUS CELLS IN VITRO. Paola Misiti Dorello, M. Boccacci, M. Quintiliani, and E. Strom (Istituto Superiore di Sanita, Rome). Rend. Ist. Super. Sanita, 27: 105-25(1964). (In Italian)

The effects of iodoacetic acid and of x rays on the incorporation of ^{32}P and thymidine-^{3}H into DNA of rat thymus cells in vitro were studied. Iodoacetic acid, at concentrations up to 10^{-4}M, did not affect the oxygen consumption by thymus cells incubated for 1 hour at 37°C. On the contrary the inhibition of the incorporation of ^{32}P as well as of tritiated thymidine into the DNA was proportional to the iodoacetic acid concentration, and it was total at 10^{-4}M concentration. The inhibitory effect of x rays was confirmed. However the experimental results seem to indicate that the ^{32}P uptake is slightly more radiosensitive than the thymidine uptake. When both treatments were combined (iodoacetic acid plus x rays) no additivity of the effects was detected. The effects of iodoacetic acid and x rays on the ^{32}P incorporation into the non-nucleotide acid-soluble phosphorus compounds were also studied. Both treatments induced a significant inhibition of the ^{32}P uptake into one of the components of this fraction, identified as phosphoethanolamine. (auth)

17634 LIVER TUMORS PROVOKED BY IRRADIATION. A. Lacassagne (Foundation Curie, Paris). Rev. Franc. Etudes Clin. Biol., 9: 269-72(1964).

Studies by Lacassagne and Hurst on partial irradiation of the liver of rats are reviewed. Irradiation of two exteriorised lobes with 500 to 4000 R prior to administration of a diet containing butter yellow, leading to chronic poisoning, retards the process of carcinogenesis by slowing down the proliferation of elements of the biliary canaliculi and formation of new canaliculi. This toxic dye has a mainly carcinogenic effect on the liver and produces changes consisting of alternations of destruction of liver cells and regeneration of new canaliculi by proliferation. Finally these cells are transformed to a cholangiocarcinoma or hepatocarcinoma, depending on their degree of differentiation. The principal characteristics of these progressive stages of carcinogenesis are found in descriptions of the liver lesions provoked by chronic poisoning with other carcinogens. They are also observed after chronic irradiation with radium, thorium, or radioactive gold introduced into the body. The effect of irradiation with x rays only, on the same hepatic lobes, also exteriorized, is completely different: the radioresistant hepatocytes are not destroyed, even by doses of 4000 or 5000 R, but they become incapable of normal division. This leads to a slow and progressive atrophy of the irradiated lobes. The resultant insufficiency is compensated for by a parallel hypertrophy of the non-irradiated lobes, in which the mitotic activity of the liver cells maintains the functional physiological mass of the organ. In all cases one common lesion is found, whether irradiation is by an external source or by a radioactive isotope in the hepatic parenchyma: progressive fibrous transformation of the connective-vascular tissue, leading to cirrhosis. (Excerpta Med., Sect. XXIII, 2: No. 1 (Jan. 1965))

17635 SOME ASPECTS CONCERNING THE EFFECT OF GAMMA AND X-RAYS ON THE NEUROENDOCRINAL SYSTEM OF TEST ANIMALS. Paul Ionescu. Rev. Sanit. Mil., 60: 743-50(Sept.-Oct. 1964).

A review is presented on the effects of x rays and gamma rays on various systems and organs, particularly the thyroid, thymus, gonads, and ovaries. (TCO)

17636 MAXILLO-FACIAL TRAUMATISMS IN RADIATION-WOUNDED. Gh. Chinta and C. Burlibasa. Rev. Sanit. Mil., 60: 751-5(Sept.-Oct. 1964).

On the basis of case histories, a review is presented on the maxillo-facial wounds that may be associated with irradiation, showing their evolution in the course of time and the nature of possible therapeutic measures (antibiotics, surgery, and general treatment). (OTS)

17637 EFFECTS OF X RADIATION ON COMPENSATORY PHENOMENA OF NEUROGLIA IN ASEPTIC CEREBRAL INJURY. Tiberiu Maros, Margareta M. Forika, and Nicolae Csiky. Rev. Sci. Med., Acad. Rep. Popul. Roumaine, 8: 47-50(1963). (In Rumanian)

In a study on the effects of x irradiation on the process of recovery of cerebral injury in white rats, it was established that doses of 600 R favor the restoration of the blood clot of the traumatic zone by intensifying the phagocytic function of the granular bodies. An opposite effect was observed in the case of larger doses (1000 R). (tr-auth)

17638 X RADIATION EFFECTS ON GRANULOPENIC FUNCTION OF KUPFFER LIVER CELLS. Tiberiu Maros, Ludovic Seres-Sturm, Carol Rettegi, and Agneta Blazsek. Rev. Sci. Med., Acad. Rep. Popul. Roumaine, 8: 127-30 (1963). (In Rumanian)

The effects of small doses of x radiation on the granulopenic function of Kupffer liver cells were studied in white rats. By quantitative determination of the silver fixed by these cells, it was established that irradiation (450 R), after an inhibition period of several hours, increased the capacity of silver fixation by Kupffer cells; they were normalized after 21 days. (tr-auth)

17639 MYXEDEMA AFTER THE TREATMENT OF HYPERTHYROIDISM BY RADIOIODINE. Yasuro Anno and Masaaki Hara (Tottori Univ., Yonago-shi, Nishimachi, Japan). Rinsho Hoshasen, 8: 895-900(Dec. 1963). (In Japanese)

The relation between the occurrence of hypothyroidism after the treatment of hyperthyroidism by ^{131}I, the dose received, and other factors was studied on the basis of the author's cases and the literature available. Of the author's 132 cases, the hypothyroidism occurred in 5 cases (3.8%); 2 cases were transient, and the other 3 cases (2.3%) received doses between 7000 and 8000 rad. According to the literature, the hypothyroidism occurs in 5 ~ 10% for doses of 600 to 900 rad. The cure doses for the hyperthyroidism extend over a wide range, and so the dose that causes the hypothyroidism is also varied. Therefore, it is desirable that the optimum dose be determined for each case of hyperthyroidism, considering the factors involved in the particular case. The anticipated dose calculated is not always the same as the dose received. It is not possible to eliminate completely occurrences of hypothyroidism. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964)).

17640 RELATIVE RADIOSENSITIVITIES OF WOODY AND HERBACEOUS SPERMATOPHYTES. Rhoda C. Sparrow and Arnold H. Sparrow (Brookhaven National Lab., Upton, N. Y.). Science, 147: 1449-51(Mar. 19, 1965). (BNL-8470)

The sensitivities of several woody and herbaceous species to single acute exposures of cobalt-60 gamma rays were determined. Within each group the sensitivity of each species is largely determined by its average interphase chromosome volume (interphase nuclear volume divided by chromosome number) of shoot apical meristem cells. On the basis of the calculated amounts of energy absorbed (in kiloelectron volts) per interphase chromosome at an exposure necessary to produce a given biological effect, woody species were approximately twice as sensitive as herbaceous species. (auth)

17641 IONIZING RADIATION APPLIED IN CONTROLLED DOSES AND CHARACTERISTICS OF THE BIOSYNTHESIS OF PROTEINS IN THE ORGANISM IN PRACTICAL BIOLOGY AND MEDICINE. V I. Sukharev (Central Scientific Research Dermatovenerological Inst., Ministry of Health RSFSR, Moscow). Sov. Med., No. 11, 93-6(Nov. 1964).

In previous work on the therapy of malignant forms of anemia with gastrocrin (dried and powdered pig's stomach)

treated with radium emanation in a definite dose, it was established that emanized gastrocrin was enriched in vitamin A as a result of irradiation. Similar results were obtained on emanized liver preparations used for the same purpose. When emanized foodstuffs (dried milk, eggs, and yeast) were given to underweight children, increase in weight was stimulated and even the most recalcitrant cases of hypotrophy were alleviated. Radiation emitted by radioisotopes of P and I administered parenterally for therapeutic purposes stimulated protein synthesis and hemopoiesis in the patients. When bran treated with radium emanation was given to young pigs, their rate of growth and increase in weight were equal to those of pigs that were given feed containing fish liver oil and superior to those of control pigs which received feed that contained neither fish liver oil nor ingredients treated with radium emanation. The digestive processes in pigs given emanized feed (or feed containing fish liver oil) were stimulated and the level of N, Ca, and P metabolism in this group of animals was raised in comparison with that of control pigs. Emanized meat-bone meal fed to chickens increased the rate of growth, average weight, and resistance to disease of the chickens. (OTS)

17642 CLINICAL COURSE AND SURGICAL TREATMENT OF BURN TRAUMAS OF THE MAXILLARY AREA IN DIFFERENT PERIODS OF RADIATION SICKNESS. S. Z. Zalalyutdinova (Stomatological Hospital of the Republic, Ministry of Health, Tatar SSR and Kazan Medical Inst.). Stomatologiya, 43: No. 2, 50-3(Mar.-Apr. 1964).

Eighty rabbits divided into two groups were used in the investigations. The first group received burns in the maxillary area; the burns were first surgically treated and then autoplasty was performed. No complications developed. The second group of animals was burned and then exposed to the action of ionizing radiation; radiation sickness of second and third degrees developed. Surgical treatment and autoplasty performed within 48 hours after the infliction of the burns and the application of ionizing radiation, that is in the latent period of radiation sickness, were only about 50% successful. Investigations established that this was due to the fact that the degree and period of radiation affection were not taken into consideration when treatment was undertaken. It was thus determined that treatment of the burn trauma must be launched simultaneously with therapy of radiation sickness; the best time for surgery is during the latent period of radiation sickness. Cosmetically, better results are obtained when surgery is performed in the latent period of radiation sickness than during the period of resolution of the disease. Plastic surgery of the defects undertaken during the climax of radiation sickness usually meets with little success, and may cause serious complications. (TCO)

17643 ^{59}Fe LOCALIZATION STUDIES AFTER IONIZING RADIATION ACTION (^{60}Co) BY MEANS OF SCINTIGRAPHY AND AUTORADIOGRAPHY. PART I. SCINTIGRAPHIC INVESTIGATIONS. Bruno Chone and Rudolf Wentz (Universitat, Heidelberg). Strahlentherapie, 126: 202-12(Feb. 1965). (In German)

The incorporation rate of ^{59}Fe and its distribution pattern was investigated as a function of single whole-body irradiation of rats with 100 to 1000 R of ^{60}Co gamma radiation. A combined scintigraphic and autoradiographic determination was made in order to obtain the dynamic changes in iron metabolism. This method is more accurate than either morphological or direct measurement methods. Scintigraphic results are reported and the activity values of bone marrow, liver, spleen, and peripheric blood are given graphically for a time period up to 10 days after the radiation insult. (auth)

17644 REPORT ON THE MODES OF ACTION OF SOME CYTOSTS AND IONIZING RADIATION. PART I. MORPHOLOGICAL AND FUNCTIONAL INVESTIGATIONS OF BONE MARROW AND SPLEEN OF NORMAL INBRED RATS WITHOUT INOCULATION TUMORS. Rudolf Schneider (Universitat, Marburg, Ger.). Strahlentherapie, 126: 213-35(Feb. 1965). (In German)

Morphological and functional changes in the bone marrow, spleen, and blood picture of albino rats of an inbred strain, were determined after both single and combined administration of cyclophosphamide, trisethyleniminobenzoquinone, and ionizing radiation (conventional x-ray depth therapy, x irradiation under conditions of short source skin distance irradiation, and telecobalt therapy). The following methods were used for the examination: cytology, histology, bone marrow function test with pyrifer, and karyometry of the early stages of the erythrocytes along with the determination of the blood picture. Results obtained with fractionated chemotherapy with small daily doses and cytostatic treatment with high single doses and longer lasting intervals were compared, when administered in combination with ionizing radiation. No changes were obtained with local irradiation in the normal animal without inoculation tumor. Chemotherapy, however, caused distinct modifications in both types of administration. Those changes disappeared rapidly. High dosages of cytostatics caused similar changes, while low doses showed only relatively selective effect. (auth)

17645 INVESTIGATIONS OF COMBINATION SICKNESSES. PART II. ON THE INFLUENCE OF DOSE AND DOSE RATE ON THE COMBINED EFFECTS OF WHOLE-BODY IRRADIATION AND OPEN SKIN WOUNDS ON MICE. Hanns Langendorff, Otfried Messerschmidt, and Hans-Joachim Melching (Universitat, Freiburg i. B.). Strahlentherapie, 126: 247-52(Feb. 1965). (In German)

Previous studies have shown a high increase of radiation mortality in mice receiving an open skin wound between the 2nd and 9th day after an irradiation with an LD 26/30 (510 R). An increased mortality was observed in the animals receiving doses far below those producing a lethal effect (100, 200, 300, 450 R), if the irradiation was accompanied by an open wound on the back (2 days after exposure to radiation). Fractionation of a dose of 510 R, which resulted in a significant decrease of the radiation effect, also showed a high mortality, if an open skin wound was added. (auth)

17646 EFFECTS OF 200 r OF 200-kv X- AS WELL AS 200 r ^{60}Co GAMMA WHOLE-BODY IRRADIATION IN MICE IN UTERO. PART I. BRAIN AND SKELETON MALFORMATION AFTER ONE-TIME IRRADIATION ON THE 10th DAY OF PREGNANCY. Juergen Kollath and Johannes Trautmann (Stadtisch Krankenhauses Moabit, Berlin). Strahlentherapie, 126: 253-7(Feb. 1965). (In German)

Ten day old embryos of laboratory mice were subjected to whole-body irradiation with 200 R of either 200 kv x rays or ^{60}Co gamma rays. There were no statistically significant differences between the two groups in regard to the occurrence of malformations or the death rate. (auth)

17647 EFFECTS OF 2,4-DINITROPHENOL ON THE RADIOINDUCED DOMINANT LETHAL FACTORS IN DROSOPHILA MELANOGASTER. Elvira Nickel (Universitat, Zurich). Strahlentherapie, 126: 263-8(Feb. 1965). (In German)

The influence of 2.4-dinitrophenol on the radioinduced dominant lethal factors of Drosophila melanogaster was investigated. Administration of DNP by food or by injection to 80 or 96 hour old male larvae 4 hours prior to irradiation did not affect the number of the radioinduced dominant lethal factors. Dominant lethal factors produced by irradiation with 1000 R affected predominantly the early embryonic stages. The ineffectiveness of DNP, administered 4 hours prior to irradiation, might be explained by a possible dissimilation or by the excretion of DNP. There were anomalies in the testes of adult males irradiated during the larva stage. (auth)

17648 THE INFLUENCE OF X RADIATION ON THE VITALITY CHARACTERISTICS OF DROSOPHILA MELANOGASTER. PART I. INVESTIGATIONS OF THE LIFETIME. Horst Noethel (Freie Universitat, Berlin). Strahlentherapie, 126: 269-82(Feb. 1965). (In German)

The influence of x rays (100 kV, 17 different doses ranging from 0 to 125 kR) on the viability of insect imagoes was studied by means of the lifespan of Drosophila melanogas-

ter. Compared with the unirradiated controls, a prolongation of female lifespan was apparent, which had a maximum of 50% at 11 kR. It was correlated with, and apparently due to the radioinduced sterilization. This was confirmed furthermore, especially with chemically (by TEM) sterilized females. With increasing dose, log mean survival time decreased linearly and parallely in both sexes, except the increase mentioned; the LD_{50} is 46 kR in males and 96 kR in females. There was a normal distribution of the mortality rate in the time after exposition at each dose. Therefore, it is assumed, that always the same mechanism of damage is involved. At doses above 90 kR this mechanism was overlapped by an immediate death, as indicated especially by the appearance of an additional early mortality peak. The immediate death was identical in both sexes. According to the symptoms, it is interpreted as central nervous injury. (auth)

17649 THE TOTAL METABOLISM OF MICE AND RATS AFTER WHOLE-BODY IRRADIATION. Otfried Strubelt (Universitat, Erlangen, Ger.). Strahlentherapie, 126: 283-90(Feb. 1965). (In German)

Whole-body irradiation of rats and mice with doses from 400 to 1000 R caused a reduction in metabolism when measured daily over 21 hour periods. By this reduction in energy consumption, the organism is able to counteract, to a certain extent, the radioinduced decrease in food intake. For higher radiation doses, no value was observed below a minimum value of 80% of the normal metabolic rate. Since the basal metabolism in rats decreased later than the total metabolism after irradiation with 900 R, it was assumed, that at first the metabolism resulting from motility and food intake is reduced. Variations in metabolic activity appearing in the daily course were almost completely absent in rats and mice during the peak of radiation sickness. (auth)

17650 REDUCED GLUTATHIONE IN ERYTHROCYTES AND VARIOUS RAT ORGANS AFTER WHOLE-BODY X-RAY IRRADIATION. Heinz Wernze, Heribert Braun, and Walter Koch (Universitat, Wurzburg, Ger.). Strahlentherapie, 126: 291-8(Feb. 1965). (In German)

The behavior of reduced glutathione (GSH) in erythrocytes, liver, spleen, and heart muscle after whole-body x irradiation of rats was determined with a new paper chromatographic method, which is specific for GSH. There was an initial GSH-increase for a period up to 48 hours after irradiation with 400, 1200, and 2000 R. The increase in GSH-concentration might be caused by an increased GSH-synthesis. There were no significant changes in the GSH-level of erythrocytes and tissues up to 21 days after irradiation with 400 R. (auth)

17651 THE DYNAMICS OF THE GLUTATHIONE REDUCTASE CATALYZED GSH-REDOX STATE IN THE LIVER OF IRRADIATED RATS. Blahoslav Zicha, Zdenek Dienstbier, Jitka Borova, Jiri Benes, and Jan Neuwirt (Univ. of Prague). Strahlentherapie, 126: 299-308(Feb. 1965). (In German)

The dynamics of the reduced glutathione changes and the glutathione reductase activity were observed simultaneously in liver of rats after whole-body irradiation with 1400 R. After irradiation the glutathione content increased to 169% of the initial value. The increase showed a biphasic shape. Each maximum of glutathione corresponded with a minimum of the glutathione reductase. The importance of the values obtained is discussed. (auth)

17652 INVESTIGATIONS ON BIOLOGICAL RADIATION PROTECTION. PART 61. SEXUAL DISTINCTION OF THE RADIATION SENSITIVITY OF THE MOUSE IN THE DOSE REGION UNDER 100 r (INVESTIGATIONS WITH RADIO-IRON). Ruprecht Koch and Irma Seiter (Universitat, Freiburg i. B.). Strahlentherapie, 126: 309-16(Feb. 1965). (In German)

The radioiron incorporation into the erythrocytes of whole-body x irradiated and control female and male mice was determined. The x-ray doses varied between 20 and 75 R. Female mice had a considerably larger ^{59}Fe-incorporation than male mice. When both sexes were irradiated with 75, 50, 40, 30, 25, and 20 R, there was significantly less damage to the radio iron incorporation mechanism in the female mice, if they were irradiated 24 hours prior to the iron injection. The threshold, that is the radiation dose, which barely produced a disturbance in the radioiron incorporation was lower in females (25 R) than in males (30 R). This difference is shown statistically. (auth)

17653 CURRENT STATUS OF THE PROBLEM OF GENETIC EFFECTS OF SMALL DOSES OF IONIZING RADIATION. G. Khadzhidekov and G. Mitrov. Suvremenna Med., 15: No. 8, 48-59(1964).

A very comprehensive review on the developments of genetic malformations caused by radiation, including much data on various radioisotopes used medically or present in the atmosphere, is presented. Experimental studies and methodology are discussed in some detail. (OTS)

17654 PATHOLOGY OF FAT ABSORPTION FOLLOWING IONIZING IRRADIATION. Z. M. Gadzhieva (Inst. of Nutrition, Moscow). Tr. 2-oi [Vtoroi] Nauchn. Konf. po Vopr. "Probl. Zhira v Pitanii," Leningrad, 1962, 299-303 (1962). (In Russian)

A single irradiation, to 350 R, of adult dogs resulted in disruption of the process of emulsification and movement of fats in the crypt portion of the intestinal epithelium. The recticular syncytium of the mesenteric lymph nodes disintegrated, as a result of which drops of nonemulsified and poorly emulsified fat entered the blood vessels. Sunflower oil was concluded to be less suitable and to cause deeper morphological changes than lard. (tr-auth)

17655 INDEPENDENCE OF DEFICIENT EARLY GROWTH AND LATER REGRESSION OF $(C57BL \times 101)F_2$ MARROW GRAFTS IN $(C57BL \times 101)F_1$ HYBRID MICE. Raymond A. Popp and Gustavo Cudkowicz (Oak Ridge National Lab., Tenn.). Transplantation, 3: 155-60(Mar. 1965).

Marrow cells from individual $(C57BL \times 101)F_2$ donors were transplanted into irradiated $(C57BL \times 101)F_1$ mice to determine whether or not two traits of C57BL marrow, namely, early deficient growth in H-2 heterozygotes and later regression of established grafts in F_1 hybrids segregated independently in F_2 mice. Marrow cells from F_2 donors of $H\text{-}2^b/H\text{-}2^b$ serotype failed to grow detectably in irradiated F_1 mice as judged by the inability of the marrow to promote synthesis of DNA in recipient spleens 5 days after transplantation, when injected in doses of 5×10^5 nucleated cells; however, marrow cells from $H\text{-}2^b/H\text{-}2^k$ and $H\text{-}2^k/H\text{-}2^k$ F_2 donors grew without apparent inhibition under identical conditions. The growth pattern of F_2 marrow on transplantation into F_1 mice remained correlated with its H-2 constitution even after prolonged (~1 year) residence in primary F_1 recipients, as judged on retransplantation into secondary F_1 test recipients. In contrast to these findings with 5×10^5 grafted cells, 10^7 nucleated marrow cells from $H\text{-}2^b/H\text{-}2^b$ F_2 donors were consistently able to repopulate the hemopoietic system in F_1 mice. Moreover, the 12.5% of all F_2 marrow grafts that regressed within 10 days after transplantation were distributed among the three segregating H-2 phenotypes. Significantly, 8 of 9 grafts of $H\text{-}2^b/H\text{-}2^b$ serotype did not regress. It was concluded, therefore, that the genetic factors determining the initial growth of a C57BL marrow graft in an F_1 hybrid do not determine the ultimate persistence or regression of an established C57BL marrow in an F_1 hybrid. (auth)

17656 THE CORTICOID METABOLISM CAUSED BY FECAL MATTER (FOUND) IN URINE OF LETHALLY IRRADIATED GUINEA PIGS. C. Winkler and H. Schorn (Universitat, Bonn). Z. Klin. Chem., 1: 155-6(Oct. 1963). (In German)

Corticoid excretion is of great interest in relation to biological radiation studies. Since diarrhea occurs in acute radiation syndrome, the excreted urine can be contaminated with feces. This causes a conversion of the cortisol and can give rise to false impressions of cortisol metabolism. The type and degree of these changes are reported on the basis of experimental results. (auth)

17657 THE PRODUCTION AND ORIGIN OF DIHAPLOID PLANTS IN SOLANUM TUBEROSUM. K. Bender (Max-

Planck-Institut fur Zuchtungsforschung, Cologne). Z. Pflanzenzuecht., 50: 141-66(1963).

From 885 flowers of S. tuberosum, which were pollinated with unirradiated pollen of 2 b-Solanum species, 184 seedlings were obtained. Of these 181 exhibited hybrid characteristics and the remaining 3 were dihaploid. If the pollen of the same diploid species was x irradiated, the proportion of dihaploids was increased. A dosage of 5,000 R was particularly favorable. A dihaploid plant was obtained by self-pollination of S. tuberosum (variety Hansa) using pollen irradiated with 15,000 R, but in general, a diploid polien parent crossed with a tetraploid mother plant was found to be more successful than a tetraploid pollen parent. The variability of the 29 dihaploids is described. Some plants showed regular meiosis, others had desynapsis. Embryological investigations showed the presence of four dihaploid embryos in 6 b-endosperm. Most other ovules also had a hexaploid endosperm with either a tetraploid, or an unidentifiable embryo, or no embryo at all. Twenty-four ovules had a triploid endosperm with triploid embryo and in two cases even with hexaploid embryos. The origin of the triploid endosperm is discussed. After mitosis of the generative nucleus in the pollen tube, two sperm nuclei were usually found. Occasionally there were bridge formations between the two sperm nuclei or the restitution nuclei. Fusion of both sperm nuclei into a restitution nucleus or bridge formation of united chromosome sets with the central nucleus of S. tuberosum would provide the conditions which as embryological investigations show are necessary for the origin of dihaploid potatoes. Further methods of origin of dihaploids are discussed. Some endosperm irregularities are discussed in accordance with the hypothesis of Von Wangenheim. (P.C.H.)

17658 CYTOGENETIC INVESTIGATIONS IN ASYNAPTIC AND MALE-STERILE MUTANTS OF PISUM. W. Gottschalk and A. Jahn (Universitat, Bonn). Z. Vererbungslehre, 95: 150-66(1964). (In Dutch). (EUR-2139.d)

Studies were made on the meiosis of four x-ray-induced asynaptic mutants and two male-sterile forms of Pisum sativum. The asynaptic mutants 19 A, 41 A, 72 A, and 239 B were characterized by a gradual reduction in the chiasma frequency. This resulted in the appearance of univalents which caused numerous meiotic disturbances and a marked drop in the gamete fertility. The average values for the number of univalents per pollen mother cell varied between 5.0 (mutant 239 B) and 10.3 (mutant 72 A). At the same time the average values for the number of seeds per pod fluctuated between 0.96 (239 B) and 0.32. Gones capable of functioning were observed in only about 5% of all pollen mother cells. The proportion of functional ova was about twice this figure. The gene ms_1 of mutant 38 B caused the breakdown of meiosis in the early prophase. The gene ms_2 of mutant 71 A caused numerous disturbances in the later stages of the second meiotic division, which resulted in a high number of gones in the microsporocyte. In some of the pollen mother cells the second telophase was followed by a third meiotic division which, however, was not connected to a division of the chromosomes into chromatids. On completion of meiosis the pollen mother cell surrounded itself with an intine and an extine, so that the entire cell turned into pollen. At the same time degeneration of the protoplast occurred. In all six mutants, monomeric hereditary patterns were evidenced, the mutated genes being recessive. The cytological anomalies were therefore genetically conditioned. (auth)

17659 FIZIOLOGO-BIOKHIMICHESKIE OSOBENNOSTI DEISTVIYA YADERNYKH IZLUCHENII NA RASTENIYA. (Physiological-Biochemical Effects of Nuclear Radiation on Plants). R. A. Vlasyuk, ed. Kiev, Naukova Dunka, 1964. 201p.

The physiological and biochemical peculiarities of the effects of ionizing radiation on economically important plants and metabolism are discussed. The effects on the plant at different stages of growth, changes in pigmentation, oxidation of enzymes, and nucleic acid metabolism are considered, together with the effects of pre-sowing irradiation of seeds on the eventual harvest. Other topics are radio-induced changes in the activity of the rhizosphere microflora, characteristics of the Ukrainian soil and plant radioactivity, physiological significance of potassium fertilizers as related to their radioactivity, use of isotopes in studying root feeding, and the role of physiologically active substances in plant feeding and metabolism. (IIC-M.G.)

17660 IRRADIATION AND PLANT IMPROVEMENT. Richard S. Caldecott (Univ. of Minnesota, St. Paul). p.279-93 of "Germ Plasma Resources." Washington, D. C., American Association for the Advancement of Science, 1961.

An attempt was made to emphasize proven and theoretical considerations that suggest that, if effectively utilized, ionizing radiation should become of increasing significance to the applied geneticist. Consideration is given to achievements that occur through seed irradiation of the naturally self-fertilized cereals that occur in nature as diploids, tetraploids, and hexaploids. (P.C.H.)

17661 THE CONTRIBUTION OF CHARGE AND ENERGY MIGRATION PHENOMENA TO RADIATION INACTIVATION MECHANISMS IN ENZYMES. L. G. Augenstein and R. Mason (Michigan State Univ., East Lansing and Univ. of Sheffield, Eng.). p.23-8 of "Electronic Aspects of Biochemistry." New York, Academic Press, 1964.

Experiments on the temperature dependence of the inactivation rate in radiation inactivation of enzymes are reviewed. The implications of the results obtained are discussed. For the usual temperatures at which inactivation experiments are carried out only a small fraction of the inactivation should be attributed to ionizations per se (40-80% for radiations of quite high L.E.T.). If the temperature-independent component does include all inactivations resulting from ionizations, then it can be concluded that ionizations are of little consequence except in the inactivation of enzymes by such high L.E.T. radiations as carbon nuclei. (P.C.H.)

17662 THE INFLUENCE OF WHOLE BODY X IRRADIATION ON PROTEIN METABOLISM OF SMALL INTESTINE EPITHELIA AND LIVER PARENCHYMAL CELLS. (AUTORADIOGRAPHIC STUDIES WITH H^3 LABELED AMINO ACIDS IN MICE). J. Brueckner. Thesis, Cologne, Universitat, 1963. 51p. $2.00(Gmelin, AED-DISS. 63-701). (In German)

Results of measurements with ^3H-labeled amino acids indicate that incorporation is proportional to nucleus volume. A method for incorporation rate determination during the DNA doubling phase is described. Whole body x irradiations with doses up to 800 R had no influence on ^3H-leucine incorporation in liver and kidneys. (Gmelin Inst.)

17663 THE INFLUENCE OF SOFT X RAYS ON IN VITRO CULTURES OF PATHOGENIC FUNGI. R. Otte. Thesis, Gissen, Ger., Universitat, 1964. 82p. $2.00 (Gmelin, AED-DISS. 64-204). (In German)

The effects of 29-kv x radiation on various types of pathogenic fungi were studied. Small doses can produce a growth stimulation. Single doses between 3000 and 5000 R produce visible changes without measurable growth inhibition. Marked growth inhibition is produced by doses between 10 and 100 kR. No lethality was observed for doses up to 300 kR. (Gmelin Inst.)

17664 PHOTOPHYSIOLOGY. VOLUME II. ACTION OF LIGHT ON ANIMALS AND MICROORGANISMS; PHOTOBIOCHEMICAL MECHANISMS; BIOLUMINESCENCE. Arthur C. Giese, ed. New York, Academic Press, 1964. 451p.

Separate abstracts were prepared for four chapters. Other chapters discuss other aspects of the action of light on animals and microorganisms, photobiochemical mechanisms, and bioluminescence. (C.H.)

For abstracts of individual chapters see: 17665, 17666, 17667, and 18032.

17665 STUDIES ON ULTRAVIOLET RADIATION ACTION UPON ANIMAL CELLS. Arthur C. Giese (Stanford Univ., Calif.). p.203-45 of "Photophysiology. Vol. II." New York, Academic Press, 1964.

Results are reviewed from a number of studies on the effects of ultraviolet radiation (uv) on animal cells that demonstrate that uv radiation alters many different functions. Topics discussed include direct and indirect effects of uv on single-celled animals, the effects of far- and near-uv, the effects of uv on the cell nucleus, the action spectra of uv effects on animal cells, the influence of the physiological state on the effects of uv, thermal reactions following irradiation of animal cells, the sensitivity of cells to ultraviolet radiation during various phases of the mitotic cycle, stimulation of cell division by uv, changes in the sensitivity of nerve cells after uv irradiation, and the effects of uv irradiation of parts of a cell. (148 references) (C.H.)

17666 MUTAGENIC EFFECTS OF ULTRAVIOLET AND VISIBLE LIGHT. G. Zetterberg (Uppsala Univ.). p.247-81 of "Photophysiology. Vol. II." New York, Academic Press, 1964.

Results are reviewed from recent studies of the mutagenic effects of ultraviolet radiation (uv) and visible light. Mutation is defined as a heritable change not due to segregation or recombination of unchanged genetic material. Topics discussed include the action spectra of uv and visible light in plant and animal cells, dose-effect relationships, the effects of temperature and intensity, the influence of oxygen and peroxides, the influence of metabolic processes, photodynamically induced mutations, the genetic modification of uv-induced mutation frequency, and the molecular basis for light-induced gene mutation. (101 references) (C.H.)

17667 PHOTOREACTIVATION OF ULTRAVIOLET DAMAGE. Claud S. Rupert (Johns Hopkins Univ., Baltimore). p.283-327 of "Photophysiology. Vol. II." New York, Academic Press, 1964.

Organisms exposed to a daylight environment are subjected to both beneficial and harmful effects simultaneously. Naturally occurring harmful wavelengths in the visible and ultraviolet (uv) spectrum are discussed. Mechanisms involved in the photoreactivation of uv damage in biological systems are discussed. Numerous examples of this effect are described. (141 references) (C.H.)

Radiation Effects Therapy and Countermeasures

Refer also to abstract 17911.

17668 SIGNIFICANCE OF BLOOD GROUPS IN HOMOTRANSPLANTATION OF MARROW IN THE DOG. E. D. Thomas, S. Kasakura, J. A. Cavins, S. N. Swisher, J. W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Ann. N. Y. Acad. Sci., 120: 362-6(Nov. 30, 1964).

Ten dogs were given 1,500 R whole-body x irradiation and an infusion of allogeneic marrow from a donor matched with respect to six erythrocyte antigens. Methotrexate was given to reduce secondary syndromes. Four dogs survived. In a similar experiment with 10 dogs, in which no effort was made to match donors and recipients, three dogs survived. It was concluded that matching of donor and recipient for these six red cell antigens did not increase significantly the long-term survival rate of lethally irradiated dogs with allogeneic marrow grafts. (auth)

17669 ROLE OF INSULIN AND OTHER COMPOUNDS IN OXIDATIVE PHOSPHORYLATION AFTER WHOLE-BODY IRRADIATION. Allan L. Goldstein and James C. Hall (Rutgers State Univ., Newark, N. J.). Arch. Biochem. Biophys., 109: 442-8(Mar. 1965).

Liver mitochondria were isolated in isotonic sucrose-Versene from rats exposed to a single dose of x rays (840 R) 3 hours before sacrifice and from sham-treated controls. The effects of insulin, growth hormone, cortisone, and cystamine were studied, in vivo and in vitro, with pyruvate and citrate as substrates. Irradiation produced a significant reduction in the P:O ratios, principally by inhibiting phosphorylation. There was a slight fall in mitochondrial protein and number. Mitochondria from irradiated animals appeared to be more fragile and variable in size. Addition of insulin, either in vivo or in vitro, increased ATP synthesis and restored P:O ratios to normal. Administration of growth hormone or cortisone in vivo produced similar results, while in vitro addition improved P:O ratios by reducing O_2 consumption. Cystamine had no apparent effect. Blood glucose levels were increased by 40% 3 hours after irradiation. Insulin, growth hormone, or cortisone, injected 1 hour before sacrifice, reduced blood glucose levels by 65, 23, and 20%, respectively, but cystamine was ineffective. The data suggest that endogenous insulin is partially inactivated by whole-body irradiation, and that insulin may be an important factor in maintaining the integrity and biochemical activity of mitochondrial membranes. (auth)

17670 THE MECHANISM OF ACTION OF THE PROTECTIVE EFFECT OF LYSOZYME AGAINST PAN-IRRADIATION DAMAGE. A. L. Costa, A. Costa, and M. Spadaro (Universita, Messina, Italy). Atti Soc. Peloritana Sci. Mat. Nat., 9: 359-70(1963).

Four groups of 5 rabbits each were subjected to a single dose of 700 R x rays. The animals of the first group (controls) received an intravenous injection of 1 ml saline every 12 hours; the second group was treated with 5 mg lysozyme in 1 ml saline every 12 hours before irradiation, the 3rd and 4th groups with 10 and 125 mg respectively of lysozyme in 1 ml saline every 12 hours for the whole length of observation. In the controls, the lysozyme and leukocyte levels in the blood underwent severe reduction. Blood iron and glucose levels fell less drastically. In the 2nd group (pre-treated with lysozyme and then irradiated) and still more in the 3rd and 4th groups (treated with lysozyme before and after irradiation) both lysozyme and leukocyte levels underwent minor changes and in some cases their values exceeded the initial ones after 60 days of treatment. On the basis of these results a mechanism of protection from ionizing radiation is postulated, concentrated apparently in the leukopoietic system; the eutrophic and stimulating activity exercised by this system limits the toxic effects of the irradiation applied subsequently and allows the use of higher doses of ionizing radiation, which are better tolerated. (Excerpta Med., Sect. XXIII, 2: No. 2(Feb. 1965))

17671 PROTECTION OF SKIN HOMOGRAFTS IN ANIMALS SUBMITTED TO PAN-X-RAYS AND LYSOZYME TREATMENT. A. L. Costa, A. Costa, and M. Spadaro (Universita, Messina, Italy). Atti Soc. Peloritana Sci. Mat. Nat., 9: 371-5(1963).

Rabbits submitted to whole-body irradiation with x rays (700 R) showed after 7 days of treatment a severe fall in blood leukocytes, lysozyme, and gamma globulins. Rabbits pretreated with lysozyme and then whole-irradiated showed no such changes. Fifteen days after the experiment, in both groups of animals skin grafting was performed; the period of preservation of the grafts in the rabbits of the second group was at least by 7 days longer than in the first group. This phenomenon is probably due to the eutrophic and stimulating action exercised by lysozyme on the bone marrow, which limits the toxic effects of the irradiation and of the inflammatory processes from the skin grafts. (Excerpta Med., Sect. XXIII, 2: No. 2(Feb. 1965))

17672 ON THE MECHAMISM OF 5-FLUOROURACIL-INDUCED RESISTANCE TO ULTRAVIOLET IRRADIATION IN ESCHERICHIA COLI. R. Ben-Ishai, B. Z. Cavari, H. Golden, and S. Kerpel (Israel Inst. of Tech., Haifa). Biochim. Biophys. Acta, 95: 291-301(Feb. 8, 1965).

In Escherichia coli B acquisition of 5-fluorouracil-induced resistance to ultraviolet irradiation appears together with incorporation of the analogue into messenger ribonucleic

acid, and accumulation of this ribonucleic acid fraction. Upon removal of the analogue, rapid turnover of the 5-fluorouracil-containing messenger ribonucleic acid occurs and loss of resistance results. The postulate that accumulation of messenger ribonucleic acid may be involved in the acquisition of resistance to ultraviolet light, was supported by experiments in which bacteria were subjected to a nutritional shift from rich to minimal medium or pre-incubated with chloramphenicol prior to irradiation. Analysis of deoxyribonucleic acid hydrolysates of irradiated control and 5-fluorouracil-grown bacteria showed that the analogue-induced resistance to ultraviolet light is not accompanied by a corresponding decrease in thymine-dimer formation. (auth)

17673 STUDIES ON THE EFFECTS OF IRRADIATION OF CELLULAR PARTICULATES. V. ACCELERATION OF RECOVERY OF PHOSPHORYLATION BY POLYANIONS. Henry T. Yost, Jr., Stewart S. Richmond, and Laurence H. Beck (Amherst Coll., Mass.). Biol. Bull., 127: 526-37 (Dec. 1964).

Male rats exposed to 800 R gamma radiation were injected post-irradiation with various polyanions and polycations and with a cell-free extract of rat spleen. Inactivation of oxidative phosphorylation by the irradiation was reversed by the spleen extract and by the polyanions, but not by the polycations. The data suggest that one of the functions (and possibly the only function) of cell-free extracts derived from spleen tissue is the restoration of oxidative phosphorylation in irradiated organisms. Since this effect can be duplicated by any of several commercially prepared polyanions, it seems unlikely that the spleen has in it a special agent responsible for effecting radiation protection. The data obtained with oxidative phosphorylation are in no way contradictory to the cellular replacement hypothesis of increased survival after exposure to radiation; they merely explain a possible mode of action of humoral agents that are known to have a limited effect on survival. Failure of polyethylene sulfonate (PES) to increase survival under the same conditions in which it recouples phosphorylation would seem to indicate that survival and regeneration of the phosphorylation mechanism are independent processes. (auth)

17674 RESEARCH ON THE BIOCHEMICAL MECHANISM OF OROTIC ACID IN RADIATION PROTECTION. M. Marchetti, B. Barbiroli, and C. M. Caldarera (Universita, Bologna). Boll. Soc. Ital. Biol. Sper., 39: 1819-21 (1963). (In Italian)

The effects of the administration of orotic acid in the diet on the RNA and DNA content and the free nucleotides in the liver and the enzymatic activity in rats exposed to ^{60}Co γ radiation of 600 R were determined. The results showed that there is no significant difference between the irradiated animals, those irradiated and treated with orotic acid, and the controls with respect to the nucleic acid content. This was varified by the free nucleotide spectra. The polynucleotide-phosphorylase activity was the same in the irradiated and treated animals as in the controls although it was significantly reduced in rats irradiated only. Aspartic-transcarbamilase activity was reduced in rats treated with orotic acid. (J.S.R.)

17675 SPECIFIC FEATURES OF THE OUTCOME OF TRANSPLANTATION OF FOREIGN HEMATOPOIETIC AND LYMPHOID CELLS IN THE MIDLETHAL IRRADIATION RANGE. K. Nouza and Alena Lengerova (Inst. of Experimental Biology and Genetics, Czechoslovak Academy of Sciences, Prague). Folia Biol. (Prague), 11: 17-33(1965).

The disease induced by grafting allogeneic bone marrow or spleen cells to midlethally irradiated mice was analyzed. Transplantation was carried out across the H-2, H-3, and H-Y barrier in various combinations of host and donor strains. Although spleen cells appear more effective in causing mortality than bone marrow inocula when one-donor-equivalents of both are compared, it was found that bone marrow can be more effective when its amount is increased to equal to that of spleen cells from one donor and occasionally even if in a quantitative disadvantage. In the attempt to appreciate the relative significance of HvG and GvH way of immune interactions in an allogeneic system, one or the other direction of reaction was either inhibited or potentiated on various principles. The morphological background of changes underlying the midlethal dose phenomenon was followed on parallel groups of mice. It was concluded that the GvH reaction, though potentially possible, is of lesser significance in the presence of the HvG reactivity. If the latter is, however, avoided, the GvH reaction takes over the activity and is fully competent to cause similar damage (in terms of rate of mortality) even though the mechanism appears more complex. (auth)

17676 EFFECTS OF POLYVINYLPYRROLIDONE ON WHOLE-BODY-IRRADIATED RATS. H. Teir, L. R. Holsti, and P. J. Taskinen (Univ. of Helsinki). Intern. J. Radiation Biol., 8: 353-7(1964).

Polyvinylpyrrolidone (PVP) given intraperitoneally four times at 12-hour intervals reduced the mortality of rats exposed to whole-body irradiation by 650 R, but hastened post-irradiation death when the dose was 800 R. The granulocyte-rich ascitic fluid produced by the injection of PVP did not possess either protective or therapeutic qualities when injected into rats subjected to whole-body irradiation. (auth)

17677 REDUCTION OF STRONTIUM-90 BONE CANCER BY ZIRCONIUM CITRATE. G. E. Zander-Principati and J. F. Kuzma (Marquette Univ., Milwaukee). Intern. J. Radiation Biol., 8: 427-37(1964).

Groups of 500 mice were injected intraperitoneally with either a high, intermediate, or low cancerogenic dose of ^{90}Sr (0.44, 0.34, and 0.20 $\mu C/g$, respectively) in order to establish norms of malignant bone-tumor production with each dose-level. Other similar groups were given the same doses of ^{90}Sr, but were treated with zirconium citrate or zirconium citrate and Diamox, a diuretic. Periodic sacrifice of each group was carried out at 6, 8, 10, 12, and 16 months after injection of ^{90}Sr. Gross or radiographic evidence of bone tumor was confirmed by histological examination. The beneficial effect of zirconium citrate was manifested by a reduction of 45 (minimum) to 72% (maximum) in the frequency of tumor bearing animals, and by lower tumor-rates in all groups treated with zirconium citrate. The effect of zirconium citrate on bone-tumor production and on the body burden of ^{90}Sr was independent of the dose of ^{90}Sr. No additional benefit was derived from Diamox treatment. (auth)

17678 USE OF HeLa CELLS IN RADIOPROTECTION EXPERIMENTS IN VITRO. J. Kahn and J. H. Barnes (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 8: 507-8(1964).

Studies were made on the growth of HeLa cells irradiated after treatment with sodium tripolyphosphate (TPP) or AET. The HeLa cells were exposed, at room temperature, to a nominal dose of 500 R x rays. Following irradiation normal growth-medium was added and the cultures were maintained at 37°C for 11–15 days with two or three changes of medium. The results suggest that TPP, in a concentration corresponding to the protective dose in mice, does not protect HeLa cells from radiation damage, which agrees with other evidence that this agent protects in the whole animal by a systemic effect. Experiments using AET as the protective agent were less conclusive, but there was some indication of protection in vitro. (P.C.H.)

17679 QUANTITATIVE STUDIES ON COLONY-FORMING UNITS IN ISOGENIC RADIATION CHIMERAS. John H. L. Playfair and Leonard J. Cole (Naval Radiological Defense Lab., San Francisco). J. Cellular Comp. Physiol., 65: 7-18(Feb. 1965).

Lethally irradiated LAF_1 mice were protected by various numbers of isogenic bone marrow cells. At intervals, cells from femoral bone marrow and spleen were assayed for their content of colony forming units (CFU) by retransplanation into other lethally irradiated mice and counting of spleen nodules at eight days. CFU numbers in femoral marrow were restored to preirradiation levels by about

eight weeks. In the spleen, restoration was earlier and more rapid and for several weeks the CFU content exceeded the normal level. Prior splenectomy did not alter the pattern of CFU restoration in the femoral marrow postirradiation. However, splenectomy did appear to slightly improve survival of irradiated marrow-protected mice. It is argued that the CFU may not be the essential protective cell, and the existence of a precursor stem cell in normal marrow is postulated. (auth)

17680 RADIOSENSITIVITY CHANGES IN LABORATORY RODENTS AND MONKEYS DURING THE ADMINISTRATION OF SEX HORMONES. B. A. Lapin and S. A. Romanova (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Med. Radiol., 10: No. 1, 49-54(Jan. 1965). (In Russian)

The investigation was carried out on male and female albino mice, albino rats, guinea pigs, as well as on male monkeys. Ten days before irradiation (absolutely lethal doses) female sex hormones (folliculin, estradiol-benzoate, synestrol, diethylstylbestrol-propionate), or the male sex hormone–testosterone-propionate, were introduced to experimental animals. Administration of the referred to preparations augments the radioresistance of animals; this effect was well pronounced in male animals but was insignificant in female animals. The protective effect depends, apparently, upon the degree of sexual maturation, since the administration of hormones to sexually immature animals does not change their radiosensitivity. The introduction of sex hormones increased the radioresistance of animals, however it did not prevent the development of infectious complications, which in such instances run a very severe course. (auth)

17681 MODIFICATION OF THE ACTION OF IONIZING IRRADIATION ON ESCHERICHIA COLI BY 2-FLUORO-ADENOSINE. Robert F. Pittillo and Mary Lucas (Southern Research Inst., Birmingham, Ala.). Nature, 205: 824-6 (Feb. 20, 1965).

Experiments with growing cells of E. coli were performed in which the test compound (2-fluoroadenosine) was added to the glucose-salts medium at the time of inoculation and aliquots of cell suspensions irradiated at varying times during the growth cycle. Data are compiled from several representative experiments, which showed the potentiating action of 2-fluoroadenosine on ^{60}Co irradiation damage of non-proliferating cell cells of E. coli ATCC 9637. The effect was found to be dose related. Other non-proliferating wild-type cultures of E. coli responded differently. It was also found that for potentiation to occur, 2-fluoroadenosine must be present during irradiation. (P.C.H.)

17682 THE THERAPY OF ACUTE RADIATION SICKNESS IN THE DOG. H.-A. Ladner (Universitat, Freiburg i. B.). Naturwissenschaften, 52: 34-5(1965). (In German)

The therapeutic effect of pyridoxal-5-phosphate after whole-body irradiation on dogs was investigated. The administration of the phosphate after irradiation with 400 R affected the acute radiation sickness favorably. Treatment after 700 R exposure had an unfavorable effect. (J.S.R.)

17683 THE PROTECTIVE EFFECT OF AESCULINIC ACID AGAINST EXPERIMENTALLY INDUCED RADIATION SICKNESS IN RABBITS. V. Todorov and I. Ushev (Higher Medical Inst., Sofia). Nauchn. Tr. Visshiya Med. Inst., Sofia, 41: 91-7(1962). (In Russian)

Tests were carried out concerning the protective qualities of the luminescent compound Esculin (Acidum Aesculinicum) on rabbits x irradiated three times with 400 R, once with 800 R, and two times with 800 R. It was found that rabbits protected by a 20% Esculin solution were affected by a less pronounced and more transient leukopenia than nonprotected rabbits. The lethality of rabbits irradiated with 800 R was by 15.5% lower than that in nonprotected controls. It is suggested that the protective effect of Esculin is due to photoreactivation phenomena. (auth)

17684 RADIATION SENSITIZATION OF MICROCOCCUS RADIODURANS, SARCINA LUTEA, AND ESCHERICHIA COLI BY P-HYDROXYMERCURIBENZOATE. A. K. Bruce and W. H. Malchman (State Univ. of New York, Buffalo). Radiation Res., 24: 473-81(Mar. 1965). (NYO-3319-1)

The high radioresistance of M. radiodurans resulted from radical-trapping materials present in the cell, as based on evidence obtained by assay of survival and of binding by neutron activation analysis. For a given dose of x radiation M. radiodurans tolerated a far higher concentration of p-hydroxymercuribenzoate (HMB), which binds — SH groups, without a change in survival than did the other cell types. The slope of the survival curve was decreased by HMB more for M. radiodurans than for S. lutea or E. coli B/R. In M. radiodurans only bound HMB was effective in producing sensitization, whereas in S. lutea and E. coli B/R loosely bound or free reagent was also effective. The quantity of HMB bound by the M. radiodurans cell was far greater than that bound by E. coli B/R and S. lutea and was consistent with the amount deduced present in extracts of M. radiodurans when compared for protective ability with β-mercaptoethylamine (MEA). (auth)

17685 GENETIC EFFECT OF LOW RADIATION DOSES AND THE PROBLEMS OF CHEMICAL RADIOPROTECTION. N. P. Dubinin and L. G. Dubinina. Radiobiologiya, 4: 854-61(1964). (In Russian)

S-aminoethylisothiouronium, serotonin, and streptomycin introduced before 50- or 100-R irradiations definitely protected the chromosomes in human tissue culture cells. The protection, which varied from zero in phase G_2 to 60% in the prophase or synthesis phase, was maximum for 50-R doses. With 25-R doses none of the chemicals offered protection in any phase. With a 38-R dose, at 19 and 26 hr after irradiation the chromosomes had lost the ability to be protected by serotonin. Twelve hours after irradiation this ability was retained; it was lost for a 25-R dose. The threshold of the protective effect was 25 R for gamma rays; the equivalent for x rays was 12.5 R. (tr-auth)

17686 ON THE RECOVERY OF PLANT CELLS FROM AFTER-EFFECTS OF IRRADIATION. E. M. Protopopova and L. N. Kublik. Radiobiologiya, 4: 878-83(1964). (In Russian)

The frequency of chromosome aberrations in irradiated barley seeds protected with β-alanine depended on the concentration of the preparation. This protective effect is not related to a rate change in the processes at different phases of the mitosis cycle. ATP, dinitrophenol, and chloramphenicol decreased the number of chromosome aberrations, the decrease being about the same for the 3 substances at the concentrations studied. (tr-auth)

17687 EFFECT OF BETA-MERCAPTOPROPYLAMINE INFLUENCE DECREASING THE NUMBER OF CHROMOSOME BREAKAGES IN TRADESCANTIA PALUDOSA MICROSPORES RESULTING FROM GAMMA-IRRADIATION. N. L. Delone and V. A. Kozlov. Radiobiologiya, 4: 922-3(1964). (In Russian)

In nonirradiated Tradescantia paludosa flowers whose stems were in water and β-mercaptopropyl amine solution, chromosome rearrangements were 0.05 and 0.07%, respectively. In irradiated preparations, values were 5.5 and 3% respectively, showing some protective effect of the chemical. (IIC-M.G.)

17688 CHEMICAL PROTECTION OF CHLORELLA AGAINST UV-RADIATION. S. A. Durymanova. Radiobiologiya, 4: 923-4(1964). (In Russian)

The survival rate of Chlorella vulgaris cells in cultures was decreased by 0.03M hydroquinone, but 0.005M thiourea, 0.03M hydrosulfite, and 0.03M potassium iodide had little effect. The first three preparations had a protective action against both the inactivating and mutagenic effect of uv light. (IIC-M.G.)

17689 INVESTIGATION OF RADIOPROTECTIVE ACTIVITY OF SOME NEWLY SYNTHESIZED THIAZOLINE DERIVATIVES. V. S. Shashkov, V. M. Fedoseev, T. E. Burkovskaya, P. P. Saxonov, V. V. Antipov, and Yu. N. Evdokimov. Radiobiologiya, 4: 927(1964). (In Russian)

Most of the organic sulfur preparations studied in 1200 white mice were 2 to 5 times more toxic than amino-

ethylthiazoline and aminoethyl isothiourea. These compounds did not offer radiation protection at the concentrations tested. This latter property is related to the failure of these compounds to hydrolize in the organism to protective compounds. (IIC-M.G.)

17690 CHANGE OF SORPTION PROPERTIES OF THYMUS CELL NUCLEI JUST AFTER GAMMA IRRADIATION. E. G. Plyshevskaya and A. M. Kuzin (Inst. of Biological Physics, Moscow). Radiobiologiya, 5: 17-20(1965). (In Russian)

Rapidly advancing changes in properties of the nuclei of rat thymus cells after 1000 R whole-body irradiation, expressed as increase in fluorescence in the nucleus-acridine orange system, were observed by a spectral method. The changes did not occur in isolated nuclei under the same conditions. The changes were temporary, and 2 to 4 hr after irradiation no increase in fluorescence was observed. The significance of these changes in development of radiation damage was shown by their absence in animals protected by β-aminoethylisothiuronium. (tr-auth)

17691 HYPERBASOPHILIC CELLS AS AN INDEX OF PROLIFERATION OF MARROW TRANSPLANTED INTO IRRADIATED DOGS. M. N. Novikova (Inst. of Hematology and Blood Transfusion, Moscow). Radiobiologiya, 5: 68-71(1965). (In Russian)

Unusual cells with basophilic protoplasm and, often, immature nuclei were seen in the blood of dogs that were x irradiated to 600 R and then given bone marrow transplants. The hyperbasophilic cells appeared 2 to 4 days after the transplantation; became maximum at 14 to 21 days, and then decreased. The dynamics of the number of these cells agreed with the dynamics of other donor elements (leukocytes, erythrocytes). Such cells were not observed in the acute radiation syndrome in dogs that did not receive marrow transplants. They were found 3 months after transplants were made to nonirradiated 2–3 day old puppies. With doses of 800 to 1000 R, there were more such cells and they reached a maximum earlier than in the 600-R irradiated animals. The cells came from cells in the transplants. (tr-auth)

17692 EXPERIMENTAL INDUCTION OF LEUKEMIA IN ANIMALS BY X IRRADIATION — EFFECTIVENESS OF ACTH IN ITS PREVENTION. Kiyoshi Hiraki, Ichiro Iwazaki, Shozo Irino, Shigeru Arimori, Yasuo Kawanishi, and Nori Muneta (Okayama Univ., Japan). Sogo Rinsho, 12: 1219-27(June 1963). (In Japanese)

Lymphatic leukemia was experimentally induced in 30- to 40-day-old RF mice by x irradiation, and a cytological and histological study of blood cells and lymph glands was made. The x irradiation was given at 200 kvp and 15 ma with a dosage rate of 33.5 R/min, totaling up to 350-R single irradiation dose to the total body. ACTH was administered subcutaneously once (0.01 mg/g) after irradiation. Blood specimens were taken from the tail vein and smear preparations made using the May-Giemsa staining method. The results showed that the occurrence of leukemia was greatest with the radiation dose of 350 R. After 300 days lymphatic leukemia was induced in 88.2% of the mice with no significant variation by sex. The leukemia observed was of two types: the thymus type with swollen thymus and WBC count of less than 30,000 or 40,000, and a nonthymus type with increase of WBC count to 100,000 or over and moderate swelling of lymph glands and spleen. Subcutaneous injection of ACTH immediately after x irradiation was effective in lowering the occurrence of leukemia to 38.4%, compared with 88.2% in uninjected controls, as well as prolonging latent period of the disease and life of the leukemic animals. (TCO)

17693 REPORT ON THE HISTOLOGY AND CYTOLOGY OF THE IRRADIATED THYMUS. PART III. THE EFFECTS OF SUBLETHAL DOSES. Hildegard Braun (Universitat, Freiburg i. B.). Strahlentherapie, 126: 236-46(Feb. 1965). (In German)

The composition of the rat thymus was investigated during the first 24 hours after whole-body irradiation with 400, 200, or 50 R. A considerable number of lymphocytes migrated from the organ immediately after irradiation with 400 or 200 R. A latency time of 6 hours was observed after irradiation with 50 R. The highest pyknosis values were measured 6 to 8 hours after irradiation. 46% of all cells showed pyknosis after 400 R, 39% after 200 R, and 11% after 50 R. Investigations using an electron microscope showed that the damage to the lymphocytes starts initially by indifferentiable events in mitochondria and ribosomes. There was a phagocytosis of whole lymphocytes with undifferentiable cytoplasm about 4 hours after irradiation. A damage to lymphocytes, characterized by hyperchromatosis of the nuclear membrane and formation of vacuoles, was observed 8 to 12 hours after irradiation. (auth)

17694 INVESTIGATIONS OF THE EFFECTS OF CATALASE IN THE RADIATION DAMAGE TO ERYTHROCYTES. Erwin Magdon (Institut fur Krebsforschung, Deutsche Akademie der Wissenschaften, Berlin). Strahlentherapie, 126: 258-62(Feb. 1965). (In German)

Radiation effects studies on suspensions of Wistar rat erythrocytes were found to be influenced by both oxygen concentration and dose rate. The results showed that the radioinduced inactivation of catalase depends on the dose rate only in oxygen containing suspensions. The radioinduced hemolysis and the K^+-loss also depend on the dose rate in O_2-containing suspensions. The fact that the radiation effect decreases with increasing dose rate, confirmed the assumption that catalase exhibits a radio-protective effect by forming a complex with the hydrogen peroxide, which is produced in O_2-containing solutions at a higher dose rate. (auth)

17695 TREATMENT OF THE RADIATION SYNDROME WITH CYCLIZINIUM CHLORIDE (MARZINE). K. I. Fochem (Universitat, Vienna). Therap. Umschau, 21: 222-4(1964).

Marzine is an antiemetic by which nausea and vomiting in radiation sickness can be controlled. The effect appeared very soon after administration. For treatment of radiation sickness parenteral administration was more suitable than oral treatment. Side-effects were not seen and effects on other symptoms of radiation sickness were negative. (Excerpta Med., Sect. XXIII, 2: No. 1 (Jan. 1965))

17696 THE INFLUENCE OF CERTAIN SYMPATHETICOTROPIC SUBSTANCES IN THE SURVIVAL OF WHITE MICE SUFFERING FROM RADIATION SICKNESS. M. S. Mikhlin and E. I. Floka. Tr. Kishinevsk. Gos. Med. Inst., 16: 126-9(1962). (In Russian)

White mice (22–25 g) irradiated to 600 R survived 8 days. Intraperitoneal injection of 1:10,000 adrenalin doubled the survival time, although 1:5,000 adrenalin had no protective effect. Ephedrine, 0.5%, cut the time to 1 or 2 days. Atropine in 1:1,000, acetylcholine in 1:5,000 and 1:10,000, and Redergam had little or no effect. The radiation protective action of the sympatheticomimetic substances cannot be explained entirely by their vasoconstrictor properties and the decrease they cause in tissue oxygen. 134 animals were used in the experiment. (IIC-M.G.)

17697 RECOVERY IN X-IRRADIATED MAMMALIAN CELLS. M. M. Elkind (National Cancer Inst., Bethesda, Md.) and W. K. Sinclair. p.165-220 of "Current Topics in Radiation Research. Vol.I." Amsterdam, North-Holland Publishing Co., 1965.

Experiments on recovery in x irradiated mammalian cells in culture are reviewed. Survival of Chinese hamster cells after fractionated doses, repeated recovery, post-irradiation division kinetics, age-response function of Chinese hamster cells, response after fractionated dose as function of cell age, temperature dependence of response to fractionated doses, and model for response of Chinese hamster cells after fractionated doses are discussed. (P.C.H.)

Radiation Hazards and Protection

See also HEALTH AND SAFETY.

17698 REPORT OF THE RBE COMMITTEE TO THE INTERNATIONAL COMMISSION FOR RADIATION PROTECTION AND FOR RADIOLOGICAL UNITS AND MEASUREMENTS. Kernenergie, 7: B181-203(Oct. 1964). (In German)

A study on the significance and application of the RBE (relative biological effectiveness) in radiation protection is presented. It represents a comprehensive survey of the theoretical basis and experimental data available. The origin of the present RBE value, specification of the radiation quality, experimental RBE data, generalizations from the experimental data, application to men, dependence of the RBE on the radiation energy, evaluation of the dose equivalent, RBE values for accidental radiation exposures and emergency radiation exposures, problems of acute radiation burden, and limits of the RBE concept are discussed. 99 references are included. (J.S.R.)

17699 DECREE ON RADIOLOGICAL PROTECTION AND ITS APPLICATION. (Staatliche Zentrale fur Strahlenschutz, Berlin). Kernenergie, 7: 705-12(Oct. 1964). (In German)

The provisions of the decree on radiological protection promulgated in June 1964 are explained fully. The necessity for new radioprotection regulations, the extent of the new law, definition of the maximum permissible doses, approval procedures for use of ionizing radiation, justification and qualification for such use, construction and planning of radiation sources, requirements on institutions using radiation, radiation monitoring, territorial monitoring, and regulations in the event of unusual occurrences are considered. (J.S.R.)

17700 RISKS AND DAMAGE DUE TO X-RAY EXPOSURE IN CHILDHOOD. A. Limonta (Osp. dei Bambini, Milan). Lattante, 35: 132-68(1964).

Foremost among the biological effects of x radiation three problems emerge: radiosensitivity; risk; and effective damage. It is justifiable to admit a greater radiosensitivity of the tissues generally in children compared with grown-ups because of their high reproductive activity and the notable component of immature cells. The greater radiosensitivity of the tissues in children conditions a higher risk. This, on its part, is determined also by other factors, in the first place by the dose: volume relationship which in relation to the size of the body is notably greater in the child than in the adult, and by the greater probability that during the long life that awaits the child an appreciable effect will be reached by summation of doses. As for somatic damage, that derived from radiography is remote. Only in tomographic and angiocardiographic examinations can high doses be reached. It is obvious that the greatest damaging effects are met with in radiotherapy. Among the somatic damages from therapeutic use of radiation (x ray, gamma) in children some are certain, such as disorders of bone growth, radiation nephritis, hypoplasia of the mamma, cataract; others are doubtful, like cancer of the thyroid and leukemia from irradiation of the thymus. The uncertainties are much greater with regard to genetic damage. The degree of radiosensitivity of the infantile gonads is as yet quite unknown. With respect to mutagenic activity, it is admitted that in the male radiosensitivity of the gonads is less than in the adult because in children the germinal elements are quiescent and, according to observations, mutagenic sensitivity is greater in the ripening than in the immature germinal elements. In females the risk of damage is greater in infancy and childhood because of the presence in the feminine gonads of a great number of ripening elements. There is no known threshold for genetic damage, and therein lies the danger of radiation of the gonads. In conclusion, it is stated that no medical treatment is free of risks. Ionizing radiations are subject to the same rule. The risk depends on the dose and the technique of irradiation. Used for medical purposes, x rays often represent an indispensable means for diagnosis and cure. (Excerpta Med., Sect. XXIII, 2: No. 1 (Jan. 1965)).

17701 RADIATION PROTECTION IN THE HANDLING OF Sr^{90} IN DERMATOLOGICAL PRACTICE. H.-J. Koerner. Zentr. Arbeitsmed. Arbeitsschutz, 14: 137-40(1964).

Measurements were made on irradiation equipment using ^{90}Sr for dermatological practice. Methods to simplify the handling of such equipment are advocated. (Excerpta Med., Sect. XXIII, 2: No. 1 (Jan. 1965))

Radiotherapy and Radiodiagnosis

Refer also to abstracts 18268 and 18340.

17702 (TID-20600) RADIATION PROTECTION PROBLEMS ASSOCIATED WITH RADIOACTIVE GOLD. Egilda D. Witherell and Russell F. Cowing (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.). [May 7, 1964]. Contract AT(30-1)-901. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Radiation protection procedures are described for hospital personnel caring for patients to whom colloidal ^{198}Au has been administered for the control of malignant effusions. Procedures are described for the administration of colloidal ^{198}Au, for the calculation of radiation dose from patients and from aspirated fluids, and for the disposal of these fluids and excreta. (C.H.)

17703 RADIOSENSITIVITY OF THE VARIOUS TYPES OF CERVICAL CANCER. F. Nogales, R. Ruiz de la Prada, V. Gimeniz Tebar, and J. Botella Llusia (Faculty of Medicine, Madrid). Acta Ginecol., 15: 199-215(1964).

The correct technique of treating cervical cancer should be based on the biopathological properties of each particular case. The prognostic examination of each case, based on the biological properties of the newgrowth and on the immunitary properties of the mesenchyma, should serve as a guide for the future conduct to be adopted. In cases of poor response to the irradiations, surgery should be the rule. (Excerpta Med., Sect. XXIII, 2: No. 1 (Jan. 1965))

17704 MEASUREMENT OF PORTAL BLOCK BY RADIOACTIVE TRACER STUDIES. Ralph Eichhorn, Mansour Maleki, Philip Johnson, and Sam Simkin (Baylor Univ., Houston, Tex.). Am. J. Gastroenterol., 40: 571-8(Dec. 1963).

A new isotopic method for the estimation of portal blood pressure is described. The development of portal hypertension slows the flow in the superior hemorrhoidal plexus and causes more blood to pass into the systemic circulation by the inferior hemorrhoidal plexus. Thus, radioactivity injected into the area drained by the superior hemorrhoidal plexus passes primarily through the portal circulation in normal subjects and primarily through the inferior hemorrhoidal and systemic circulation in patients with portal hypertension. If this tracer is temporarily trapped by the liver, there would be a delay in its appearance in the systemic circulation in normal subjects, but if there is portal block this material would bypass the liver appearing first in the heart via the systemic circulation. Using two radioactive detectors, one over the liver and one over the heart or systemic circulation, it is then possible to monitor externally the difference in appearance time of the radioactivity in the liver and right auricle respectively. It was found that Iodopyracet labeled with radioiodine produces a significant difference between the appearance of this substance in the liver and its appearance time in the heart area in normals which disappears in the presence of portal hypertension. This technic was used in 30 patients and found to be useful in the determination of portal block. The range of injection-to-liver time in patients with cirrhosis and/or portal hypertension varied from 26 to 148 sec. In normal individuals, the variation ranged from 26 to 100 sec. The average injection-to-liver time, however, for cirrhotics was 54 sec. and for normals 79 sec. This test was able to detect two

cirrhotics in two alleged normals. Iodopyracet, after it enters the systemic circulation, is rapidly excreted by the kidneys. An average of 42% (25 to 50%) of an intravenously injected dose was excreted into the urine in 30 min. This suggests that the excretion of Iodopyracet is relatively fast and thus would not constitute a radition hazard. (BBB)

17705 PREOPERATIVE IRRADIATION FOR CARCINOMA OF THE COLON AND RECTUM: A PRELIMINARY REPORT. William S. Fletcher, Clifford V. Allen, and J. Englebert Dunphy (Univ. of Oregon Medical School, Portland). Am. J. Surg., 109: 76-83(Jan. 1965).

Complications and histologic response of the tumors to irradiation are described. The preoperative irradiation consisted of a therapeutic dose of irradiation to the tumor of 5000 R. The irradiation reaction invoked is such that operation is delayed from four to six weeks to obtain max shrinking of the lesion and resolution of the reaction to a degree consistent with major surgery in that field. A 2-Mev Van de Graaff generator operating at 100-cm distance with a half value layer of 6.8 mm lead was used with treatment fields to include the primary tumor but not the regional nodes. The average field size was about 10 by 10 cm although a few patients required irradiation of nearly all of the pelvis because of the extent of the tumor. All but one of the 27 patients showed a reduction in size of the tumor mass by the time therapy was completed and further reduction occurred in later weeks. In only one case there was no reduction in size of the neoplasm during or following the administration of 5000 R in 58 days through opposing anterior and posterior fields. These patients tolerated the planned doses well, without serious complication, and the adenocarcinomas showed good response to this treatment. Only one patient was required to discontinue therapy after 3500 R because of poor general condition. Skin reactions were minimal in the patients in whom the general condition was good at the onset of therapy. The usual skin reaction was a slight erythema. There were 13 complications in the 27 patients undergoing resection after irradiation, a complication rate of 48%. This was an improvement over a control series of 162 patients operated on in which mortality was 9.3% and there were 171 complications in the 162 operated patients. Histologic examination of the irradiated tumors showed the following: (1) no significant change in the grade of malignancy, as judged histologically, between the pretreatment and post-treatment tissues; (2) a change in the size of the lesion as described clinically before treatment and that found by histological examination; (3) change in size of the lesions related to central necrosis of the tumor which appeared partly on a vascular basis; (4) degree of necrosis could not be correlated with the amount of irradiation (it was not determined how much of the necrosis of the tumor related to irradiation response and how much to spontaneous necrosis); (5) lymph nodes found in treated cases were smaller and showed a depletion of the lymphoid tissue and prominent reticuloendothelial cell activity; (6) extramural extension of the tumor and number of positive lymph nodes found did not differ significantly in the treated cases from the control cases. (BBB)

17706 A NEW CASE OF TETANY FOLLOWING THE TREATMENT OF THYROTOXICOSIS WITH RADIOACTIVE IODINE. A. Helou, E. Tyan, and M. Zara. Ann. Endocrinol. (Paris), 25: 238-43(1964).

The sixth known case of hypoparathyroidism following treatment of thyrotoxicosis with ^{131}I is reported. The peculiarity about this case is its persistence, 3 years after its appearance, and the necessity for continuing substitution therapy with A.T. ic. The case is discussed in the light of the five previous reports. None of the causative explanations so far proposed appears conclusive, but the presence of a predominant parathyroid in the thyroid tissue seems most probable. (Excerpta. Med. Sect. XXIII, 2: No. 1 (Jan. 1965))

17707 TREATMENT OF TUMORS OF THE FEMALE GENITAL TRACT WITH ISOTOPES. G. Vecchietti and A. Onnis. Attualita Ostet. Ginecol., 9: 583-624(1963).

After a study of the physical characteristics of isotopes used in gynecology, the technical possibilities of their use are discussed at some length. Intraperitoneal injection has given satisfactory results in the treatment of ovarian tumors with metastatic spread in the peritoneum. It can be employed prophylactically as well as therapeutically, though the latter may still be only of a palliative treatment. Parametrial infiltration with ^{198}Au offers the possibility of irradiating either the parametrial tissues or the regional lymph nodes of the uterine cervix, and notable concentration of the isotope inside the pelvic lymph-nodes will often destroy the cancer metastases. The intrauterine application of beta-emitting radioisotopes, which is still in an experimental stage, could supplement or support radium therapy inside the uterus in endometrial neoplasms, while isotopes which are still being studied with regard to their possibilities and dosage would permit systemic application in the clinic. Endolymphatic infusion of radioisotopes has given encouraging results and can be regarded as a useful addition to surgery. (Excerpta Med., Sect. XXIII, 2: No. 2, (Feb. 1965))

17708 RADIATION LYMPHOGRAPHY IN GYNAECOLOGICAL ONCOLOGY. G. Vecchietti, A. Onnis, and A. Romagnolo. Attualita Ostet. Ginecol., 9: 659-727(1963).

The technique of radiation lymphography in gynecological oncology and the radiological and morphological pictures of lymph nodes after infusion of lipiodol U.F. ^{131}I and colloidal ^{51}Cr are described in detail. Contraindications to the method are few, mainly pregnancy and serious lesions of the liver and kidneys. The lymph edema can persist for some time (4-6 weeks) and is well tolerated by the patients. Lymphography can replace: parametrial infiltration of ^{198}Au (by its advantages of dosage, distribution of radioactivity, harmlessness, etc.), which is applied for its action on the pelvic lymph nodes; and the application of radiferous tubes along the pelvic lymph chains, though it does not act in the tissues surrounding the lymph nodes, because of its undoubted efficacy and lesser traumatisation. It can, besides, be associated with supplemental external radiotherapy with its complete sterilization of the lymph nodes, the surrounding tissue, the parametrium, etc; with surgery, guaranteeing sterilization of the lymph glands either before lympho-adenectomy (of remaining glands) or before an enlarged hysterectomy by the abdominal or vaginal route. The diagnostic information offered by lymphatic infusion can be useful to determine therapy either by surgery or radiation. (Excerpta Med., Sect. XXIII, 2: No. 2(Feb. 1965))

17709 THE PELVIC LYMPH-NODES IN CARCINOMA OF THE UTERINE CERVIX. A. Onnis and A. Bertolin (Universita, Padua). Attualita Ostet. Ginecol., 9: 729-60(1963).

Based on a large case material and on data from the literature, research was carried out on the metastatic spread of cancers of the uterine cervix in the lymph nodes. The morphological pictures of lymph nodes were studied in various conditions of the disease and after diverse radiation treatments: radium therapy, telecobaltotherapy, endolymphatic infusion, isotopes, etc. (Excerpta Med., Sect. XXIII, 2: No. 2(Feb. 1965))

17710 DEPTH DOSE TABLES FOR USE IN RADIOTHERAPY. A SURVEY, PREPARED BY THE SCIENTIFIC SUBCOMMITTEE OF THE HOSPITAL PHYSICISTS' ASSOCIATION, OF CENTRAL AXIS DEPTH-DOSE DATA MEASURED IN WATER OR EQUIVALENT MEDIA. Brit. J. Radiol., Suppl. No. 10, 108p.(1961). London, British Institute of Radiology, 1961.

Depth dose data are included for x rays, gamma rays, and electron beams. Information on: the equivalent field method for axial dose determinations in rectangular fields; conversion of percentage depth doses from one F.S.D. to another, and the calculation of tissue/air ratios; equivalent half-value thicknesses; and the variation of percentage depth dose with beam quality is appended. (P.C.H.)

17711 THE USE OF Pb^{210} FOR PROMPT DIAGNOSIS OF LEAD POISONING. Comit. Nazl. Energia Nucl., Notiziario, 10: No. 5, 50-1(1964).

A review is presented on research on the use of ^{210}Pb for the prompt diagnosis of lead poisoning cases in the U. S. (Excerpta Med., Sect. XXIII, 2: No.2(Feb. 1965))

17712 NEW RADIOTHERAPEUTIC PROCEDURES FOR THE TREATMENT OF ENDOCRINE EXOPHTHALMOS. Gy. Petranyi, S. Fazakas, Jr., and G. Gat (Univ. of Debrecen, Hungary). Endokrinologie, 46: 285-8(1964). (In German)

The authors report results of initial studies with ^{131}I administered to patients with exophthalmic goiter in relatively small doses of 50 to 200 μC each. These small doses were given repeatedly for 6 to 19 times over periods of 1 to 3 weeks. The hormone synthetic activity of the thyroid was not affected by doses as small as these. Five patients with prominent edematous retrobulbar exophthalmos were treated in this manner. Four of them were thyrotoxic and for this they were also treated with the usual amount of ^{131}I, without reduction of the optic symptoms. Later, after they were treated with the small doses of ^{131}I two of these patients were found to have decreased Hertel values, and in the two others worsening of their symptoms was halted. In all four patients there was indication of some improvement, as suggested by a reduction in inflammation of the eyelids. In the fifth patient the ophthalmological symptoms were unchanged by the treatment. The improvements observed were ascribed to effects of ^{131}I irradiation on the production of TSH (thyroid-stimulating hormone) by the hypophyseal-hypothalamic centers. (BBB)

17713 PLASTIC SURGERY WITH PERITONEAL FAT FLAPS IN REPAIR OF VESICOVAGINAL FISTULAS. M. Pecherstorfer (Universität, Vienna). Geburtsh. Frauenheilk., 24: 1079-84(Dec. 1964). (In German)

Various techniques for plastic surgical repair of fistulas developing between the urinary bladder and vagina, as a result of intensive radiotherapy for pelvic cancer, are reviewed. Ten cases are described in which the fistulas were repaired by use of a peritoneal flap of fat tissue to close the defects in the bladder and vagina during surgery. Six of the present cases developed fistulas after radical operation for uterine cancer was followed by intensive irradiation. In all cases the fistulas were in the trigonal and retrotrigonal areas of the bladder. The largest fistula measured 25 mm in diameter. The surgical technique, which is not a new one, is described. After cutting through the fistula, the surgeon draws fatty tissue from the peritoneal cavity down over the resulting defects and sutures it so as to close the defects both in the bladder and vagina. Illustrations of the surgical steps required are provided, and the success of the operation in four cases is described in detail. Although this is an old method, attention is called to it because of its successful application in these cases. (BBB)

17714 EVALUATION, SELECTION OF QUALITY, AND DOSAGE IN THE IRRADIATION OF INFLAMMATORY SKIN DISEASES. Carl Georg Schirren (Universität, Munich). Hautarzt, 14: 489-93(Nov. 1963). (In German)

Irradiation therapy is less used for treatment of inflammatory dermatoses, such as chronic eczema, psoriasis, furunculosis, hydradenitis, pruritis, or deep mycoses than in past years. These diseases are often treated now by antibiotics or cortisone, especially when they are located near gonads, or if the age and irradiation history of the patient make irradiation inadvisable. During 1961 out of a total of 13,591 dermatologic patients, only 728 were irradiated, and in 559 of these, the irradiation was for treatment of tumors. When skin diseases are irradiated, the amount and quality of the radiation used must be graded to the severity and depth of the pathologic process treated. For treatment of the pyoderma, depending on the severity, a single irradiation should amount to between 20 and 100 R, or in extreme cases, at most 150 R. The more acute the lesion, the lower the unit dose should be. The dose may be repeated at one- or two-day intervals. For eczema and psoriasis treatment the single dose may vary between 60 and 100 R, and the total dose may be 240 or 300 R. Thus, if 80 to 100 R are given each time, three treatments are required. If less than 240 R is given results are often unsatisfactory. Treatments are given once or twice a week. Sometimes, more frequent treatment, but with lower dosages, gives more rapid healing. In general, if the single dose given is somewhere between 60 and 100 R, the length of time required for healing is rather variable, and may amount to 2 or 3 weeks. The use of low doses of 20 to 40 R each, given 7 or 8 days apart for chronic cases, is probably not advantageous, but the tissues may be damaged less than with higher single doses. (BBB)

17715 X-IRRADIATION OF PERIANAL GLAND NEOPLASMS IN THE DOG. Joe P. Morgan and William D. Carlson (Colorado State Univ., Fort Collins). J. Am. Vet. Med. Assoc., 143: 1227-30(Dec. 1, 1963).

Treatment of perianal gland neoplasms with x irradiation was compared with the results obtained with surgery. Small lesions less than 2 cm in dia were treated with a single depth dose ranging from 800 to 2000 R of 280-kv x rays. Larger lesions ranging up to 8 cm in dia were given a depth dose of 300 to 400 R for 5 to 10 treatments extended over 12 to 25 days. The x-ray beam was angled so that the rectum was spared the total depth dose to avoid possible rectal constriction. In 56 perianal gland neoplasms in 44 dogs treated with radiation, a higher percentage of regression was noted at 12 months post-therapy than in 25 similar neoplasms in 17 dogs treated surgically. At the end of one year, 55.7% of the neoplasms treated with radiation had not recurred, whereas 45.5% of those treated surgically had not recurred. At the end of two years, 32.5% of the neoplasms treated with radiation had not recurred, whereas only 11.1% of those treated surgically had not recurred. Postirradiation effects were infrequent and minor in most dogs. These effects included depigmentation of the skin, loss of hair, moist dermatitis, and latent growth of white hair in the treated area. Two dogs had persistent diarrhea for as long as 6 weeks after irradiation. One dog had severe rectal constriction attributed to the radiation, and another, constipation, possibly due to partial rectal constriction. (BBB)

17716 150 CASES OF RADIOACTIVE YTTRIUM GRAFTING IN THE HYPOPHYSIS IN THE TREATMENT OF ADVANCED BREAST CANCER. TECHNIQUE—CLINICAL RESULTS—INDICATIONS. P. Juret, M. Hayem, and A. Flaisler (Inst. Gustave Roussy, Villejuif, France). J. Chir. (Paris), 87: 409-33(1964).

Studies were made on 150 intrahypophyseal implantations of radioactive yttrium in patients. The surgical method employed is described and it is emphasized that technical details outlined have to be strictly adhered to if complications that have marred this operation in the past, such as fistulae, meningitis, or neural lesions, are to be avoided. The proportion of objective remissions amounted to 37% for the entire case material, but reached 46% in the last 50 patients. Half of the objective remissions obtained lasted for more than a year. The longest period so far observed approaches 4 years without symptoms of recurrence. Bone metastases were most readily improved, next the nodular skin metastases, then the pleuro-pulmonary ones. Important factors in prognosis were the time interval between mammectomy and the appearance of the first metastases, and the level of androsterone and etiocholanolone have considerable importance. Cerebral and hepatic metastases could represent a contraindication to the operation, but not necessarily so. The proportion of subjective remissions and of pain relief obtained in women with painful bony metastases was very high (86%). The pain relief achieved renders implantation of yttrium the therapeutic method of choice in such lesions when the classical analgesics are ineffectual. On the basis of the latter results yttrium implantation was extended to cases of bone metastases in cancers of the prostate and other non-hormone-dependent cancers (uterus, parotid gland, rectum). Similar pain relief was achieved. Some of the problems posed by this operation are discussed. A comparison was made between yttrium implantation and classical hypophysectomy and adrenalectomy. Yttrium-90 implantation appears to be the method

most adapted to the particular field of these diseases, provided that the surgical imperatives described are meticulously observed. (Excerpta Med., Sect. XXIII, 2: No. 2 (Feb. 1965))

17717 HYPERTHYROIDISM TREATED WITH RADIOACTIVE IODINE. Jonathan C. Gibbs, Jr., R. V. Grieco, and James E. McKeown (Jersey City Medical Center, N. J.). J. Med. Soc. New Jersey, 60: 392-4(Aug. 1963).

Iodine-131 was used to treat 104 goiter patients. Data are provided on accurate dose estimation, improved fractional dose techniques, prevention of hypothyroidism, and scintiscanning to detect nonhomogeneous dose distribution in the thyroid gland. To avoid irradiation sequelae no juveniles, women under 35, or possibly pregnant women were treated. The diagnosis was established in each case by one or more ^{131}I uptake tests, basal metabolism test, and serum protein-bound iodine (PBI) determination. The ^{131}I uptake was used as a major guide, the normal range for a test being 15 to 45%. All patients had uptakes of from 50 to 99% and high uptake normals were eliminated by using the tri-iodothyronine suppression test. Initial individual therapeutic dose was between five and six mC both for diffuse and adenomatous toxic goiters with an average dose of 5.6 mC. In 58 cases of diffuse toxic goiter, the average total dose was 6.9 mC with a range of 2.6 to 18 mC. Average time required to reach a euthyroid state was 4.7 months with a range of 2.2 months. Additional therapy was given three months after the initial dose if the patient was not euthyroid as determined by a repeat uptake and scan, PBI, and clinical re-evaluation. Six patients became hypothyroid. The incidence of hypothyroidism is greater in diffuse goiter because too large an initial dose may be giver tc the inherent difficulty in determining dosages. The generally recommended dosage being 80 μC retained per g of gland. The fractional weekly dose technique was adopted to overcome this problem. In 46 cases of toxic adenomatous goiter, the average total dose was 10.3 mC with a range of from 4 to 36 mC. Average individual dose was again 5.6 mC. One patient was not euthyroid after 48 months with a total dose of 28 mC. None became hypothyroid. Toxic adenomatous goiters were refractory to treatment because the uptake and distribution of radioiodine was not uniform throughout the gland at the time the first dose is given. Scintiscans showed that the adenomatous gland functions segmentally and sequentially collects ^{131}I, and the unaffected areas continue to be hyperactive. Subsequent doses suppressed different areas until all of the functioning units had been uniformly irradiated. The scans showed how different functioning areas pick up varying amounts of ^{131}I in patients with toxic adenomatous goiter. This aspect of therapy is overcome by giving larger doses, the average being 50% for the first dose. This may be overcome by fractional dose procedure. Repeated 0.5 mC doses are given at weekly intervals until a permanent, uniform uptake by the functioning and resting segments of the gland is obtained. Attempts have been futile to determine the proper dosage by actual size, weight, and palpation. A standard initial dose of five mC is practical if large dose regimen is to be followed. However, to reduce the low incidence of hypothyroidism, the fraction 0.5 mC dose technique may be utilized. (BBB)

17718 RADIATION THERAPY FOR CANCER OF THE CERVIX: ITS LATE EFFECT ON THE LIFESPAN AS A FUNCTION OF REGIONAL DOSE. Henry I. Kohn, John C. Bailar, III, and Calvin Zippin (Univ. of California, San Francisco). J. Natl. Cancer Inst., 34: 345-61(Mar. 1965).

To investigate the degree of life shortening in man after radiation exposure, the survival of patients who were treated for cancer of the cervix exclusively with x rays and/or radium was studied. The group includes only those who were treated prior to age 55 and who survived at least 5 years to eliminate early deaths due to cancer. The 499 admitted cases were drawn from 2 cancer registries (University of California and Connecticut State Department of Health) and were grouped by stage of disease at diagnosis (stage I, states II–III) and by regional dose [low, 1-18 millions of gram-Rads (Mg-Rads); middle, 19-27 Mg-Rads; high, 28-54 Mg-Rads]. Thus far 24% of the patients have died. Comparisons among the 12 stage-dose groups of the 2 registries showed no significant differences among 11 of them. This failure to find a clear-cut diminution in survival related to increment in radiation dose is consistent with 2 other reports on cervical cancer patients. The incidence of leukemia also appeared to be strikingly lower than in Japanese bomb survivors who had received a similar integral dose of radiation which, however, was distributed much more uniformly throughout the body. (auth)

17719 RADIOHIPPURAN RENOGRAPHY AND RADIOHIPPURAN RENAL AUTOFLUOROSCOPY. E. M. Sigman, M. Bender, and M. Blau (Buffalo General Hospital). J. Urol., 92: 153-8(1964).

A new isotope procedure, renal autofluoroscopy, is discussed. It appears to have certain advantages over the conventional renogram in that the non-renal components are reduced to a minimum, while the renal components may be studied compartmentally and quantitatively. Renal autofluoroscopy and radiorenography are useful adjuncts in evaluation of renal function under both clinical and experimental conditions. (Excerpta Med., Sec. XXIII, 2: No. 2(Feb. 1965))

17720 A STUDY ON THE INFLUENCE OF ESTROGEN ON RADIOSENSITIVITY OF PATIENTS WITH CERVICAL CANCER: ITS CLINICAL AND HISTOLOGICAL ASPECTS. Hajime Sugimori (Kyushu Univ., Fukuoka, Japan). Kyushu J. Med. Sci., 14: 355-68(Dec. 1963).

Chemical and histological studies were conducted to determine whether administration of estrogen influences the radiosensitivity of cervical cancer. Thirty-four patients with cervical cancer were administered estrogens combined with radiotherapy; 27 others were treated by radiation only. The estrogen group showed somewhat better radiation response both in clinical and histological criteria. Side-effects of estrogen administration, such as withdrawal bleeding, vulvar swelling and hyperemia, and breast tenderness, were observed in a few patients. However, severe complications were not seen, even though a few cases of metastasis were observed in the estrogen group. Histologically, administration of estrogen produced hyperemia and edematous changes in the stroma. A marked response was observed in 27 out of 34 cases (79.4%) of the estrogen-treated group, and in 15 out of 27 cases (55.5%) of the control group. There was a tendency of the radiation response to occur earlier and to be more marked in the estrogen group than in the control group. These histological radiation responses were fairly well correlated with the clinical responses. However, no relation between histological radiation response and the amount of estrogen given was observed. It is suggested that these histological findings cannot be used to evaluate radiosensitivity. Since estrogen administration produces hyperemia in the stroma of cancer tissue, this increase of blood supply should increase the oxygen supply. It is postulated that the elevation of oxygen tension induced by estrogen in this manner would enhance the radiosensitivity of the tumor and tumor bed. On the other hand, this increase of blood supply to cancer tissue may accelerate metastasis as described in some cases. (TCO)

17721 CHANGES OF THE ULTRASOUND RESISTANCE OF ERYTHROCYTES AND THROMBOCYTES DURING THE RADIATION TREATMENT OF WOMEN WITH CANCER. Sandor Csoemoer, Janos Nagy, Jozsef Gazso, and Jozsef Varga (Orvostudomanyi Egyetem, I. sz. Noi Klinika, Budapest). Magy. Radiol., 16: 351-4(Dec. 1964). (In Hungarian)

Tests were conducted on 24 women suffering from carcinoma of the uterine corpus or cervix to determine the effects of Ra and x-ray treatment. The treatment consisted of two 200-R x irradiation doses daily and 1800 to 3600 mg-hr Ra treatments; measurements were taken before initiation of the treatments, after 4000 R and 1800 mg-hr Ra, and after 6000 to 8000 R and 1800 to 3600 mg-hr Ra treatments. The ultrasound resistance values were determined by placing 2 ml properly diluted blood in a 3 ×

10^6 c frequency and 2 w/cm^2 intensity ultrasound chamber. Erythrocyte and thrombocyte counts were determined before and after the ultrasound treatment. Thrombocytes were separated by 50 g centrifugal force for 5 min rather than the customary sedimentation. The results showed that erythrocyte count decreased very slightly during treatment, from 3.8 to 3.6 × 10^6 per mm^3, but ultrasound measurements indicated that their resistance is not changed by radiation treatment. It is concluded therefore, that circulating erythrocytes are not structurally damaged by radiotherapy. The reduction in their number is due mainly to damage to bone marrow and to the anemic tendency of patients with carcinoma. Thrombocyte count, however, decreased as the treatments progressed (from 260 to 193 × 10^3 per mm^3) and their resistance also decreased, confirming that thrombocytopenia develops after major radiotherapy. It is concluded that the thrombocytes in circulation are damaged by radiotherapy rather than thrombocyte-producing factors. (BBB)

17722 UROLOGIC COMPLICATIONS OF RADIOSURGICAL TREATMENT OF CANCER OF THE CERVIX. A. Tetti and G. Chiaudano (Universita, Turin). Minerva Ginecol., 16: 133-67(1964).

Urologic complications observed after treatment of cancer of the cervix in patients treated at the Department of Obstetrics and Gynaecology of the University of Turin from 1957 to 1962 are reported. For each year, all forms of treatment given in the 550 cases admitted during the same period were analyzed in relation to the stage of the tumor. The aetiopathogenesis is discussed, and the difficulties encountered in this clinico-statistical assessment are considered. All methods of urologic examination are listed, and 27 cases out of 226 examinations made, in which urologic complications were found, are analyzed and illustrated. No urological lesions could be observed in cases of cancer of the cervix uteri at the first stage treated radiologically, but a urinary change occurred when extensive surgery was associated with it. From this it was deduced that destructive surgery has a causal connection with the pathogenesis of the urological lesion. As for the second stage, there is the possibility of damage either by the irradiation treatment alone or radiosurgical therapy of surgery alone; this would demonstrate that the responsibility for the urological damage is attributable to a common factor in all these cases, and is probably related to the spread of the neoplasm and involvement of the parauterine tissues in the tumor. Such extension of the tumor beyond the limits of the uterus is evidenced by the therapeutic action of either radiology or surgery with the manifestation of lesions which more easily affect the urinary sector because of its close connections with the genital sector. It follows from this that the prime mover of the potential urological lesion is the extension of the tumor beyond the uterus, while the direct surgical or radiological cause constitute a releasing moment which acts on a tissue that is biologically predisposed to an abnormal reaction. (Excerpta Med., Sect. XXIII, 2: No. 1, (Jan. 1965))

17723 RADIOISOTOPES IN NEUROLOGICAL DIAGNOSIS. G. Cazzato (Universita, Bari, Italy). Neuropsichiatria, 19: 485-533(1964).

The use of radioisotopes in clinico-diagnostical and physiopathological problems of a neurological nature are reviewed. The contribution from gammaencephalography with radioiodized serum albumin in the examination of the intracranial spaces is emphasized. Radioisotope studies of the encephalic circulation, the use of G.E.G. in neuropathology, the results of myeloscintigraphy, and the difficulties inherent in the study of cerebrovascular lesions with focus are covered. (Excerpta Med., Sect. XXIII, 2: No. 2(Feb. 1965))

17724 STUDIES ON THE INTEGRAL DOSE. I. CALCULATION OF THE INTEGRAL DOSE OF THE WHOLE BODY AT 200 kv X-RAY WITH WORTHLEY AND WHEATLEY'S (x). Nobuo Yamashita and Goro Nakamichi (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gaddai Zasshi, 23: 1053-7(Dec. 1963). (In Japanese)

The integral dose was calculated at 200 kvp deep therapy using Worthley and Wheatley's (x) and the value obtained was compared with those calculated from Mayneord's formula. The results were found to be 10 to 30% larger than values from Mayneord's formula. This appears to be due to the fact that scattering radiation outside of the cone of the main beam is not considered in Mayneord's formula. (P.C.H.)

17725 STUDY ON THE INTESTINAL ABSORPTION OF D-XYLOSE IN PATIENTS IRRADIATED IN THE ABDOMINAL-PELVIC REGION. L. Dalla Palma, G. Grechi, and S. Salmon (Universita, Florence). Nuntius Radiol., 30: 661-82(Aug. 1964). (In Italian)

Investigations were made on the behavior of the intestinal absorption of D-xylose in 41 patients, 32 of which were irradiated in both the pelvic and low abdominal area and 9 irradiated in the high abdominal area. In the greatest majority of cases, a decrease of the xylosuria was found after doses of nearly 3000 R: such a decrease was more marked in the patients with normal initial values and after irradiation of the high abdominal region. In the patients irradiated on the pelvic area, either a stabilization, an increase, or a further decrease of the values observed after half of the radiotherapy course were observed at the end of the course. As was observed for the other substances (triolein, oleic acid, iron, vitamin B_{12}) no changes of the absorption closely proportional to the administered dose were found. The results are discussed, and various hypothesis are considered to explain the changes of the intestinal absorption of the xylose, observed in the subjects irradiated on the abdominal area. (P.C.H.)

17726 SOME CONSIDERATIONS OF THE THERAPEUTIC VALUE AND HAZARDS OF RADIOACTIVE ISOTOPES. H. Horwitz (Univ. of Cincinnati). Ohio State Med. J., 59: 68-72(Jan. 1963).

At present there are available over 1000 different radioisotopes for possible therapeutic application, but worthwhile use has been found for only about ten of these, all of which are utilized in simple inorganic form. In isotope diagnosis, routine uses have been found for about 15 isotopes, some of which are employed as tracer labels for complex organic substances. The reasons for the comparatively static state in isotope therapy are examined. Isotopic materials currently available have only low selectivity for cancer tissue. It is suggested that insufficient effort has been directed towards the investigation of tumor-seeking substances which are capable of carrying radioisotopes into the cancer cell. A tremendous advance in cancer therapy could result if such an agent were developed. For thyroid tumors, ^{131}I is of considerable therapeutic value and is perhaps the only example of an isotope specific for a cancer cell. The main types of clinical use of both internal and external radioactive sources are outlined. By far the largest therapeutic use of isotopes is as γ-ray sources for external and internal (interstitial or intracavitary) therapy. With systematically administered isotopes, three basic difficulties are of concern: dosimetry, carcinogenesis, and genetic effects. The dosimetry of radioisotopes is unsatisfactory and is still largely empirical. The question of whether or not there is an appreciable long-term risk of carcinogenesis or leukemogenesis in patients treated with radioisotopes is discussed. Late leukemogenesis and carcinogenesis, if they are to occur significantly, may show up ultimately in the large numbers of thyrotoxic patients now being treated with ^{131}I. The seriousness of the genetic hazard is not accurately known but it is better to use caution in the use of large quantities of radioisotopes for therapeutic purposes. Isotope therapy should be restricted to hospitals in which special departments have been established to handle the problems associated with large quantities of these potentially dangerous materials. Therapy with radioisotopes demands special personnel and facilities in order that receiving, storage, dispensing, handling, administering, and disposing of isotopes is carried out under full control. Furthermore, routine procedures have to be established for administering isotopes for operating room technique, ward

technique, disposal of contaminated materials, equipment and excreta, and for dealing with radioactive corpses. A table is given showing the various isotopes in common use and the diseases for which they are of value. (BBB)

17727 RADIATION PROTECTION ASPECTS IN A DIAGNOSTIC X-RAY FACILITY. J. Kereiakes, G. Meckstroth, and C. M. Barrett (Univ. of Cincinnati). Ohio State Med. J., 59: 831-5(Aug. 1963).

Protective measures for decreasing the exposure of staff and patients are outlined, after first considering the levels of dose which are permissible for the various classes of people who may be exposed. The requirements as set forth in the National Bureau of Standards Handbook 76 for medical fluoroscopic, medical radiographic, mobile diagnostic, photofluorographic, and dental radiographic units are shown. Structural barriers are discussed in terms of types, depending upon the type of radiation to which they are exposed: (a) primary barrier which shields against the primary beam; and (b) secondary barrier, which shields against the leakage radiation passing through the source shield (such as the x-ray tube housing) and against the scattered radiation. The barrier thickness required may also be adjusted for the degree of occupancy of the area considered. For example, stairways may be assumed to be occupied only $^1/_{16}$ of the time by the same person; therefore, the occupancy factor is one-sixteenth. For locations normally occupied by radiation workers, this factor is assumed to be 1. Occupancy factors for various locations are listed. Another important factor considered for a diagnostic x-ray facility is x-ray film protection. For the time duration of film storage, a total exposure dose of 1 mR is accepted for radiation shielding purposes. It is, therefore, essential that the darkroom have ample protection and that the shielding of darkroom walls be carried up to the ceiling. Also considered are specific requirements for the operator of the x-ray unit. The recommended min lead equivalent for aprons and gloves is 0.25 mm. This auxiliary protective equipment should be checked periodically by radiographic procedures to determine possible cracks that may develop with age. Its lead equivalent may be checked radiographically by comparison with a wedge composed of stacked 0.1-mm thick lead sheets. (BBB)

17728 HEAVY PARTICLES IN THERAPY. J. H. Lawrence. Presse Med., 72: 1349-52(1964).

The use of heavy particles with high energy has permitted development of true radiosurgical techniques by application of very high quantities of energy to very small areas of the body. The possibilities of this method are illustrated by the results obtained with hypophyseal destruction in patients with advanced cancer, acromegaly, or Cushing's disease and diabetic retinopathy. (Excerpta Med., Sect. XXIII, 2: No. 1 (Jan. 1965))

17729 THE TREATMENT OF MOUTH CANCER BY IRRADIATION. Paul Strickland (Mount Vernon Hospital, Northwood, Eng.). Proc. Roy. Soc. Med., 57: 251-6(Apr. 1964).

Radiosensitivity of normal and tumor cells, advantages of various radiation sources, and incidence of side-effects are considered in relation to radiotherapy of oral tumors. Generally, malignant tissues are more sensitive than normal tissues, most tumors being more sensitive than the tissues that give them origin. Among common tumors, benign ones are radioresistant, as are most soft tissue sarcomata and most adenocarcinomata. The more anaplastic a tumor is, the more radiosensitive it is likely to be and the more locally radiocurable. Conversely, differentiated tumors should, theoretically, be less radiocurable. However, this simpliciation often breaks down; many lip carcinomata are highly differentiated, yet most can be cured completely and permanently by irradiation. In conventional (250-kv) x ray treatment of lip and pharynx cancers the irradiated skin becomes sore and, as high doses have to be used, there is moist desquamation. At the same time a thick fibrinous membrane develops over the irradiated mucosal surfaces. Later, the skin heals, leaving a variable amount of pigmentation and late telangiectasia, and the mucous membrane turns to near normal. Irradiation of bone is inevitable, and these x-ray beams are more readily absorbed by the Ca and P atoms in bone than by normal tissue, so that bone ultimately receives a dose of two or three times as much as the tumor. Moreover, the bone acts as a shield for the tumor and protects it against the effect of radiation. Bone necrosis, with all the problems of osteomyelitis and sequestration, is common. In cases that respond only partially, the end-picture is a mixture of radionecrosis and residual or recurrent carcinoma. Because of these severe limitations of conventional x ray therapy, megavoltage or supervoltage irradiations are preferred. With supervoltage beams the max dose falls at a depth to the skin, at 1.3 cm in the case of the linear accelerator and at 0.5 cm with a ^{60}Co unit, so that severe skin reactions are no longer seen, and the differential absorption in bone does not occur at the supervoltage level. These beams are so penetrating that it is often possible to use a single portal instead of two or more. The volume of tissue irradiated is thus reduced. Radiation-induced tissue necrosis is inevitable with tumors of low radiosensitivity; the cancer-curing dose may be very close to the tissue-necrosing dose. Thus, the risk of necrosis must be accepted in such cases even if there is only a moderate chance of curing the patient. Where tumors are fixed to bone, and the whole area is infected, necroses are inevitable. Less acceptable is late radionecrosis, generally a response to local trauma or infection or both. The blood vessels of the irradiated soft tissues undergo progressive endarteritis obliterans which affects the blood vessels of the haversian systems as well. There is also progressive degeneration of the collagen fibers of irradiated bones. The end-result is an abnormally brittle avascular bone structure, which may fracture in response to minor trauma. (BBB)

17730 FACILITIES FOR ISOTOPE INVESTIGATION. E. S. Williams (Middlesex Hospital, London). Proc. Roy. Soc. Med., 57: 352-3(May 1964).

Arrangement of radioisotope diagnostic services in a hospital is briefly discussed. (BBB)

17731 THEORETICAL ANALYSIS OF RENOGRAM. Kin-ichi Hisada, Hiroshi Kawanishi, Kunio Tobe, and Hiroyuki Miyamura (Kanazawa Univ., Japan). Radioisotopes (Tokyo), 14: 24-32(Jan. 1965). (In Japanese)

A method of the theoretical evaluation of renograms is discussed. First it was proved through using ^{131}IHSA that it took 2 ~ 3 minutes for the administered radioactive substance to mingle equally with circulating blood. This fact led to the conclusion that the initial 2 ~ 3 minutes' portion of the renogram curve needs to be excluded in the precise evaluation of the renogram. Seven compartments were established as kinetics model of ^{131}I-Hippuran and it was found that renogram recorded up to 40 minutes could be expressed as figures of the sum of the 3 exponential functions. The procedures for the analysis of the renogram and heart curve are described. The renogram and heart curve obtained two minutes after the intravenous administration of ^{131}I-Hippuran is plotted over semilog-paper. The heart curve shows a straight line after 20 ~ 30 minutes. The second straight line (r_2) is obtained by subtracting the first line (r_1) from the initial curve. Renogram curves can be analyzed into 3 straight lines in the same way. The straight line other than r_1 and r_2, which have the same slope with the heart curve, is α_{23}. The intersection of the third line of both sides of the renogram to zero time is named as L′ and L″, respectively. $T_{\frac{1}{2}}$ and L′, L″ of the r_1, r_2, α'_{23} and α''_{23} are read. Next the time when both renograms show the maximum value τ'_1 and τ''_1, respectively are named. A method for obtaining quantitatively the shifting velocity of the ^{131}I-Hippuran is given. (P.C.H.)

17732 PRINCIPLES OF THE DOSIMETRY OF INTERCELLULAR THERAPY. THE IDENTIFICATION OF THE COORDINATE VALUES OF IMPLANTED RADIOGOLD SEEDS FROM X-RAY PHOTOGRAPHS IN TWO PLANES. Manfred Busch (Universitat, Freiburg i. B.). Strahlentherapie, 126: 161-76(Feb. 1965). (In German)

In addition to previous reports on the calculation of dose distributions for treatments with implanted radiogold seeds, a method is described that considerably facilitates the determination of the seed pattern from x-ray pictures in two planes. A computer was used to identify the values of the two pictures. The identification is a part of the program that is used for calculating the dose distribution. (auth)

17733 THE DETERMINATION OF DOSE DISTRIBUTION WITH DIGITAL COMPUTERS WITH REGARD FOR EDGE DECREASE AND SCATTERING. Juergen Richter and Dieter Schirrmeister (Institut fur Krebsforschung, Deutsche Akademie der Wissenschaften, Berlin). Strahlentherapie, 126: 177-84(Feb. 1965). (In German)

A method for obtaining dose distributions considering edge decrease as well as scattering outside of the radiation field with digital computers is described. The dose at any point P can be obtained by multiplying the central beam dose by a factor F, where F is a function of the distance from the central beam to P and half the field width at this point. F can be determined for any field size and tissue depth. Upon comparing isodoses, calculated from the true as well as from the geometric radiation field, differences of up to 15% were observed. Consequently, dose calculations based on the geometrical radiation field may be used only as an approximation method. An alternate approximation method is preferred, since the isodoses are more accurate near the focus. (auth)

17734 THE PROBLEM OF INSUFFICIENCY OF THE DOSE IN RADIUM THERAPY OF CERVICAL CARCINOMA IN STAGE I AS A CAUSE OF RECURRENCE. G. L. Dulac and P. Ragonese (Foundation Curie, Paris). Riv. Ostet. Ginecol., 19: 171-86(1964).

With the purpose of studying the possibility of insufficient dosage in intra-uterovaginal radium applications for therapy of uterine cancer in stage I, which can explain in some cases the cause of the recurrences, the roentgen dose delivered in arbitrarily pre-established anatomical points, and in applications carried out according to the Fondation Curie (Dulac) technique were calculated. The anatomical points were chosen in the uterine neck, in the vaginal fornices, in the parametria, and 2 cm anterior and posterior to the cervical canal. The theoretical calculation of the dose was made for several positions of the vaginal applicator and for the intra-uterine container, taking the diameter of the uterine cervix into account. Considering a dose lower than 6,000 R as insufficient, insufficient doses were noted especially in cases of incorrect application (particularly when the applicator dropped by 1 or 2 cm) and in cases of wide uterine cervices (diameter more than 4 cm). It is necessary to measure the diameter of the uterine cervix prior to the radium therapy; during the application itself it is necessary to made a radiological control in order to carry out additional telecobalt therapy in medium doses before the surgical treatment. (Excerpta Med., Sect. XXIII, 2: No. 1 (Jan. 1965))

17735 ENZYMIC ACTIVITIES OF THE VAGINAL FLUID IN CASES OF CERVICAL EPITHELIOMA UNDER RADIUM THERAPY. G. Careddu (Universita, Sassari, Italy). Studi Sassaresi, Sezione I, 43: 449-53(1963). (In Italian)

The results of determinations of glucose-6-phosphate-dehydrogenase in the vaginal secretions of patients with carcinoma of the cervix after radium treatment are reported. From the data obtained, it was concluded that such an investigation cannot supply prognostic informations on the efficacy of radiotherapy. (auth)

17736 METHOD FOR CALCULATING ABSORPTION DOSES OF A LONG WAVE X-RADIATION. A. N. Krongauz and A. V. Frolov (Roentzen-Radiological Inst., Minstry of Public Health, Moscow). Vestn. Rentgenol. i Radiol., 39: No. 6, 60-6(Nov.-Dec. 1964). (In Russian)

Calculations were carried out for the case of the exposure of tumors near the skin to soft x radiation. The average dose absorbed within the tumor was calculated, setting it equal to the sum of the integral absorbed doses, delivered to the sum of the mass of the volume elements of the tumor. A formula was derived for determining the ratio of the doses absorbed in the tumor and the whole body. On the basis of the dosimetric data thus obtained, it is recommended that when soft x rays are used for therapeutic purposes, the operating conditions should be adjusted in order to maximize the dose absorbed in the tumor; the ratio of the integral absorbed dose in the tumor and of the dose in the whole body should approach 1. The radiation dose is controlled by the clinical indicators, taking the histological structure into account. (TTT)

17737 A CONTRIBUTION TO RADIOISOTOPE DIAGNOSTIC HEMATOLOGICAL STUDIES WITH Cr^{51} AND Fe^{59}. H. Kuni. Thesis, Marburg, Ger., Universitat, 1963. 74p. $2.00(Gmelin, AED-DISS. 63-696). (In German)

A method for blood volume determination was developed using the patients own blood. Erythrocytes are treated with ^{51}Cr and unbound Cr is extracted by an ion exchanger. Time from the taking of the blood to reinjection is about 10 min. Fe metabolism is investigated using ^{59}Fe. A routine method for the determination of the erythroblast iron pool is given. (Gmelin Inst.)

17738 STUDIES OF THE TRANSFER OF Hg^{203} NEOHYDRIN USED FOR BRAIN TUMOR DIAGNOSIS TO RAT FETUSES AND UNWEANED RATS. W. Allmaras. Thesis, Freiburg i.B., Universitat, 1964. 100p. $2.00(Gmelin, AED-DISS. 64-207). (In German)

Gravid rats were given 5 μC ^{203}Hg–neohydrin various times ante partum. Activity in various organs of the animals was determined. A placental transfer of Hg was observed, also the milk contains Hg. Concentrations in fetuses and unweaned rats are smaller than in the parents. Radiation doses to human fetuses by ^{203}Hg–neohydrin tumor diagnosis is estimated. Total dose in the tissue of the mother is about 8 Rem for an injection of 0.7 mC. This corresponds to approximately 0.1 Rem in the fetal tissue. (Gmelin Inst.)

17739 THE BEHAVIOR OF SERUM PROTEINS AND SERUM LIPOPROTEINS AFTER APPLICATION OF THERAPEUTIC RADIATION DOSES TO PATIENTS WITH CARCINOMA. G. Kunitsch. Thesis, Marburg, Ger., Universitat, 1963. 73p. $2.00(Gmelin, AED-DISS. 63-692). (In German)

Radiation effects on serum proteins and lipids are reviewed. Methods for determination of protein and lipoprotein and changes in rabbits after 1000 and 2000 R are studied. Total protein and albumin decreased in all animals. Protein and lipoprotein levels in 30 patients with carcinoma were investigated. Total protein was not changed, albumin was decreased, and all globulins, especially α_2, increased. The fraction of the lipoproteins was lower in comparison to the β fraction. (Gmelin Inst.)

17740 STUDIES OF THE TOTAL WATER AND EXTRA CELLULAR VOLUME OF PATIENTS WITH KIDNEY INSUFFICIENCIES USING H^3 AND S^{35}. H. J. Ulrich. Thesis, Marburg, Ger., Universitat, 1963. 53p. $2.00(Gmelin, AED-DISS. 63-695). (In German)

Methods for the measurement of tritiated plasma with a liquid scintillation counter are investigated. Counting methods for ^{35}S in plasma are described. Total body water and extracellular volume were determined for normal persons and for patients with kidney insufficiencies of various origins. Total water of the latter group was about 10% higher than for normal persons (58% of body weight). (Gmelin Inst.)

17741 THE SCIENCE OF IONIZING RADIATION. Modes of Application. Lewis E. Etter, ed. Springfield, Ill., Charles C. Thomas Publisher, 1965. 799p.

Twenty-nine chapters are included on the history of the science of ionizing radiation; x-ray and radiation-therapy and diagnosis equipment; radiation physics; recording media and screens; radiochemistry and radiation chemistry; radiobiology; human applications of ionizing radiation; industrial applications; x-ray crystallography; applications in paleontology-archaeology, anthropology, graphic art, and agriculture; and radiation protection. (M.J.T.)

17742 MEDICAL RADIOISOTOPE SCANNING. Proceedings of the Symposium, Athens, 20-24 April 1964. (International Atomic Energy Agency, Vienna (Austria)). Proceedings Series. Oct. 1964. 609p. (STI/PUB/82 (Vol.I)). $11.50; S 241,50; £3.9.0; F.Fr. 46,-; DM 40,25 (IAEA).

Separate abstracts were prepared for 23 of the 31 papers included. Abstracts for 8 papers appeared in NSA Vol. 18 as numbers 5169, 17677, 19835, 20416, 33968, 35436, 35896, and 35897. (C.H.)

For abstracts of individual papers see: 17743, 17744, 17745, 17746, 17747, 17748, 17749, 17750, 17751, 17752, 17753, 17754, 17755, 17756, 17757, 17758, 17759, 17760, 17761, 17762, 17763, 17764, and 17765.

17743 THEORY OF RADIOISOTOPE SCANNING. G. L. Brownell (Massachusetts General Hospital, Boston). p.3-34 of STI/PUB/82(Vol.I).

All scanning techniques, whether utilizing focusing collimators, positron detectors or the newer camera techniques, have certain basic problems. The success of these techniques depends in large measure upon the correct choice of various parameters of the collimating system, of which the most important is the resolution. The relationship of optimum resolution to radioisotope content and distribution is discussed. Radioisotope scanning may be considered as a process of information extraction and presentation. The primary information lies in the original radioisotope distribution. The collimator and detecting system provide the information transfer mechanism and the final scan presents the resultant information. As with all such techniques, only a small fraction of the information is retained in the final scan. It can be shown that for focusing collimator and scintillation camera systems, the number of counts per resolution area varies as the fourth power of the resolution distance. For certain radioisotope distributions it is possible to derive analytically an optimum value of resolution distance. However, for most systems the optimum resolution must be determined by trial and error. The problems here are similar to those of pattern recognition in other fields. A computer program was prepared to aid in determining the optimum resolution for various types of patterns. This computer is unique in having intermediate disc storage and CRT read-out. The results have general applicability to the design of many scanning systems. (auth)

17744 INFORMATION THEORY AND RADIOISOTOPE SCANNING. J. Cederlund (Radiofysiska Avdelningen, Centrallasarettet, Boras, Sweden). p.57-75 of STI/PUB/82 (Vol.I).

The quality of a scintigram is often described in terms of resolution and contrast. Generally, these two parameters are not independent of each other. Increased resolution can usually only be achieved at the cost of decreased contrast. A fundamental problem in scanning theory is to find the best compromise between resolution and contrast. This problem can be solved if one can find a measure of the quality of a scintigram that considers both resolution and contrast. The possibility of defining the information content of a scintigram and using this as a quality measure is discussed. An elementary introduction to information theory is presented in order to enable a reader with no previous knowledge of information theory to follow the rest of the paper. A heuristic approach to the main topic is criticized and some commonly met pitfalls during the application of the information theory are pointed out. A mathematical model of a simplified scanning system consisting of a collimator and a detector is described. The amount of information available at the output of this system is calculated. The scanning system divides the scintigram into a number of image elements. With few image elements the contrast is good. If the number of elements is increased resolution is improved, but contrast is reduced. It can be shown that, under certain conditions, as the number of elements is increased the amount of information in the image first increases, reaches a maximum and then decreases. A discussion follows on how much of the potentially available information is lost in the display system, for instance through the effect of contrast enhancement. Finally, it is pointed out that high information content is a necessary, but not sufficient, condition for good quality of a scintigram. (auth)

17745 THEORY OF SCANNING AND IMAGE OF RADIOISOTOPE DISTRIBUTIONS. B. Cassen (Univ. of California, Los Angeles). p.77-87 of STI/PUB/82(Vol.I).

A simplified basic theory of the quantitative performance characteristics of radioisotope imaging and scanning systems is discussed. A figure of merit is derived, depending partly on the instrument characteristics and partly on the methodology utilized. The factors involved in the figure of merit are: the count-rate sensitivity of the detector per unit solid angle subtended from a resolution element, the solid angle subtended from a resolution element, the number of resolution elements viewed simultaneously, the number of resolution elements in the total field scanned or imaged, the dose concentration, the total time taken to produce an image or scan, and the background count-rate. The basic theory is further refined and discussed to take into account factors such as depth-of-focus resolution, variable speed or variable dwell scanning, possibilities of variable or automatically variable resolution, relative resolvability of cold and hot nodules, field size, and use of special radioisotopes and types of detectors. A discussion is presented on the handling and processing of data arising from scanning and imaging techniques. The relative merits of background eliminators and contrast enhancement procedures such as photoscanning and color scanning are analyzed. The advantages and possible disadvantages of tape recording original data and the repeated playback through contrast and background processing circuits are discussed. Some experimentally determined figure-of-merit data are presented on a widely used commercial scanner and on some new developments, especially a new high quantum utilization scanner, which is briefly described. (auth)

17746 SENSITIVITY AND RESOLVING POWER IN SCINTISCANNING. J. Courtial and A. Gandy (Foundation Curie, Paris). p.91-114 of STI/PUB/82(Vol.I). (In French)

The effect of collimator parameters on the quality of the scintigram and its properties when it is used to localize a point source are discussed. The sensitivity of the collimator is expressed as a function of its geometrical constants, followed by a definition of its fineness. This is related to its response curve in the case of a point source or its transit curve when crossing the contour of a plane source. The images obtained with scintiscanning devices when used for exploring a number of plane sources having simple geometries are discussed. Since these images cannot be interpreted with certainty because of the statistical nature of the information recorded, recourse is had to the concepts of linear resolving power and surface resolving power. The relationships between these resolving powers and the parameters of the scintiscanner are then established. These relationships provide a guide to the selection of operating conditions and make it possible to interpret the image obtained. The case of three-dimensional sources is also considered. It is first shown that the sensitivity of the perfect collimator can be expressed by the same formula as is used for plane sources. It is then shown that the concept of surface resolving power requires to be supplemented by that of depth resolving power. The latter is derived from consideration of the image of an object of simple geometry and determines the dimensional limits below which the object is no longer perceptible. The curves illustrating this concept provide a comparison of the merits of the various perfect collimators. The theoretical results can be applied in practice when certain properties of real collimators are stated. A comparison is made of the resolving powers yielded by the various methods of recording. (auth)

17747 STUDIES ON THE RELATIONSHIP OF ORGAN SIZE AND SCANNING PICTURE. R. Wolf and J. Fischer (Universitat, Mainz). p.141-52 of STI/PUB/82(Vol.I).

The quantitative relationship between scintigram area and cross-section of the organ under investigation has, up to now, been studied only in connection with determinations of the volume of the thyroid gland. In such measurements the accuracy of depiction is in many ways dependent on the equipment used, collimator, background cut-off, scan speed, etc. Yagan et al. have introduced a method for determining the size of the liver which utilizes a variable cut-off. For organs such as the thyroid gland and the kidney it is of interest to establish a clear correlation between the x ray picture or the palpation findings and accumulating and non-accumulating tissue. It is important to know precisely the size relationships, for example, in scintigraphy of the cardio-vascular blood pools. With an organ such as the spleen, which may rapidly be altered in size in various diseases, the exactitude of the scintigraphic depiction is of decisive importance. A series of phantom studies was made to determine the accuracy of the scintigraphic depiction under various conditions. The models used were made of plastic and could be filled with radioactive solutions. The investigations were carried out in air and in water and the effects of changes in concentration of the radioisotopes, as well as of various parameters such as collimator-object distance, cut-off, contrast enhancement, scanning speed, channel width of the spectrometer and the depth of the absorbing water mass over the organ, were studied. A Picker Magnascanner was used with two different collimators, 19-hole honeycomb collimator and a 31-hole honeycomb fine-focus collimator. The latter was used only for the thyroid gland. The results show that the accuracy of the depiction when using the fine-focus collimator is very sensitive to changes in the distance from collimator to object. When using a 19-hole collimator on the other hand the distance is not of great importance. It is advantageous to work with the same maximal pulse rate as far as possible in comparing sizes. By retaining the same fixed relationships between channel width of the spectrometer, cut-off, pulse rate, and scanning speed, a faithful depiction is obtained for large organs such as the spleen. (auth)

17748 THE EVALUATION OF STRAIGHT-BORE, TAPERED AND FOCUSING COLLIMATORS AS A FUNCTION OF GAMMA-RAY ENERGY. W. J. MacIntyre, J. H. Christie, and I. Tatsuno (Highland View Hospital, Cleveland). p.153-73 of STI/PUB/82(Vol.I).

In the choice of one collimator or type of collimator over another for scanning purposes, either isoresponse curves or the geometric response to a point source has been previously utilized as a basis of evaluation. While this technique is helpful in a comparison of resolution between focusing collimators, extrapolation of the results to the extended sources that are of interest in scanning is extremely difficult. For this reason, comparison of various collimators has been made with a phantom consisting of a series of flat, cylindrical discs which can be filled with radioactive material alone or displaced by a defect of specific size. This phantom has made it possible to measure the counting-rate contribution from each segment of an extended source as well as the drop due to the defect placed at various distances from the collimator. Summation of any number of such contributions then reflects the response of any desired focus of interest in the midst of any desired environment. By this system, comparisons were made of both counting rates and spatial resolution of straight-bore, tapered, and focusing collimators. Varying the gamma-ray energy demonstrated what fraction of the counting rate is due to intraseptal penetration of the focusing collimators in addition to the self-absorption and scatter of the phantom. The study indicated that no one collimator is necessarily optimal for all purposes but that whereas one collimator may be superior to another in the detection of one type of defect at one energy, the converse may be true for another type at another energy. (auth)

17749 COLLIMATOR EVALUATION WITH THE IAEA SCANNING PHANTOM. M. A. Bender and M. Blau (Roswell Park Memorial Inst., Buffalo). p.175-91 of STI/PUB/82(Vol.I).

The IAEA Scanning Phantom was designed to provide an easily reproducible large organ phantom that could be used as a standard to compare more accurately different scanning systems. A unique feature of the phantom is that when all four sides are scanned, the four tumors are each viewed at depths of 0, 5, 10, and 15 cm. The use of the IAEA phantom for the evaluation of four commonly used 3-in. focusing collimators: 19, 37, and 61 channel lead collimators and a 37 channel tungsten collimator is discussed. The optimum collimator configuration for a variety of gamma-ray energies, tumor-pool concentrations, and tumor sizes, and depths were determined. Each collimator was used with eight different isotopes emitting photons ranging in energy from 0.027 Mev to 1.3 Mev. Each isotope-collimator combination was evaluated with four tumor-pool concentration ratios. The activity in the pool was at a level consistent with that encountered clinically. Using photorecording, four sides of the phantom were scanned for every combination of collimator, isotope, and tumor-pool concentration ratio, a total of 512 scans. The scans were interpreted independently by three experienced observers. These data provide a basis for the rational choice between these collimators for various scanning situations. They also provide information on the minimum gamma-ray energy suitable for large organ scanning and the effect of septal cross-over by high-energy gamma-rays on the target: non-target ratio. (auth)

17750 THE DESIGN AND PERFORMANCE OF A LARGE HIGH-RESOLUTION FOCUSING COLLIMATOR. C. C. Harris, P. R. Bell, M. M. Satterfield, D. A. Ross, and J. C. Jordan (Oak Ridge National Lab., Tenn.). p.193-208 of STI/PUB/82(Vol.I).

The primary reason for use of a focusing collimator is to permit the use of a large detector giving increased counting rate without loss of spatial resolving power. Since many apertures aimed at a common point are used, a sort of focusing effect is achieved. Because the septa between the apertures are necessarily thin, penetration of these walls by gamma rays causes a loss of spatial resolution. Tungsten and gold have been used to reduce this penetration as compared with lead. Reducing penetration by using a longer lead collimator damages the main design objective, that of increased counting rate, unless a larger detector is also used. The design and construction are described of a 91-hole lead collimator for use with a 5.25-in. (13.5 cm) by 3-in. (7.5 cm NaI(Tl) detector. The focal point is 9.5 in. (24 cm) from the detector, and the solid angle of acceptance is the same as focusing collimators in common use with 3-in. detectors. The maximum length is 6.5 in. (16.5 cm); normal design length is 5.5 in. (14 cm). At these lengths, the optical circles of resolution are 0.476 in. (1.2 cm) and 0.304 in. (0.77 cm) respectively. The designs achieved a longer focal distance with an increase of counting efficiency due to the larger phosphor; a lead collimator with a resolving power comparable with shorter gold collimators; a high-resolution collimator for human and small animal scanning; a basic assembly design for use with larger-solid-angle collimators for increased counting efficiency. Total-body scans were made with ^{198}Au and ^{131}I. The scans indicate the increased efficiency and resolution of the 5.5-in. collimator. A ^{198}Au scan of a dog with the 6.5-in. collimator showed well a concentration of activity apparently less than $\frac{1}{4}$ in. (6mm) in diameter; the activity was only five times body background but was clearly separated by $\frac{1}{4}$ in. from a $\frac{3}{4}$-in. diameter source about 50 times more intense. (auth)

17751 CONSTRUCTION OF A HIGH-EFFICIENCY, LOW-ENERGY COLLIMATOR. R. Hoefer and A. Roszuczky (Second Medical University Clinic, Vienna). p.233-41 of STI/PUB/82(Vol.I).

The advent of ^{125}I makes it necessary to revise the conventional measuring equipment constructed for use with isotopes emitting gamma rays of a comparatively high energy. The most important modification of scanning equipment, made possible by the low gamma energy of ^{125}I, lies in reducing the thickness of the septa of the collimator. This increases counting efficiency without loss in the

resolving power of the collimating device. A focusing multichannel lead collimator with septa less than 1 mm thick was designed. The construction of such a collimator is shown in some detail and some results of studies of its efficiency and resolving power with ^{125}I are presented. (auth)

17752 LOCALIZATION AND TOTAL BODY HIGH-ENERGY GAMMA-RAY SCANNING STUDIES IN CANCER PATIENTS. J. S. Laughlin, P. J. Kenny, K. R. Corey, E. Greenberg, and D. A. Weber (Sloan-Kettering Inst. for Cancer Research, New York). p.253-72 of STI/PUB/82 (Vol.I).

A scanning system was developed for use with energetic gamma-ray-emitting nuclides, which scans either the total-body or specific portions of it and which presents the data quantitatively with a dynamic range of six orders of magnitude. This system was applied in studies with ^{47}Ca and other radionuclides in cancer patients. The system includes two large crystal detectors mounted in 600-lb tungsten and lead-shielded heads whose motion, either continuous or discontinuous, above and below patients' couch, can be programmed with great flexibility. A tungsten focusing collimator is used for fine scanning. Digital presentation provides exact data and permits statistical analysis of counting variations over body sites. Quantitative comparison was made with analog film presentation, which has a much more limited dynamic range and decreased sensitivity for detecting variations. The system was successful in the early detection and definition of bone lesions, and permitted precise metabolic and kinetic studies of bone-seeking nuclides over long periods of time. A further feature of this system is the measurement of total activity independently of concentration or redistribution in out-patient kinetic studies. Results are presented. (auth)

17753 A CLINICAL RADIOISOTOPE SCANNER FOR CYLINDRICAL AND SECTION SCANNING. D. E. Kuhl (Univ. of Pennsylvania, Philadelphia). p.273-89 of STI/PUB/82(Vol. I).

A scanner is described that was built to explore potential advantages of modifying the motion of the radiation detector over the patient. In the study of a round organ, such as the liver, a cylindrical scanning motion is used to expose more of the organ to survey. Another modification is section scanning which permits the separation of images of radioactive structures according to specific planes in body depth. This mode of scanning can be of particular use when images of body structures overlap in the recording and are confusing. During scanning the patient is supported on a cantilever platform between two opposed scintillation detectors mounted at the extremities of a yoke. The yoke is powered to provide three motions of the detectors about the patient: longitudinal, transverse, and rotary. Particular attention was paid to the precise control of detector position and speed by incorporating servo-mechanical control mechanisms. The recording system includes non-destructive data storage on punched paper tape; provision for rapid regeneration of scanning images on a cathode-ray oscilloscope; and facility for electronic operations on the image signal. Examples of the clinical applications of this instrument are described, with particular emphasis on cylindrical scanning of the liver and section scanning of the brain. (auth)

17754 CLINICAL PHOTOSCINTILLOGRAPHY: TECHNIQUE AND APPLICATIONS. K. H. Ephraim (Rotterdamsch Radio-Therapeutisch Instituut, Rotterdam). p.291-320 of STI/PUB/82(Vol. I).

For clinical applications of photoscintillography, collimation, contrast-amplification and data storing are of great importance. For the detection of space-occupying lesions in thick organs such as liver and brain, a special 3d-channel multifocus collimator was developed. The isoresponse lines of this collimator are shown. Its response hardly changes from the surface to a depth equal to the thickest part of the liver. A special contrast-amplifier was built: a small incandescent primary bulb, triggered via a pulse-amplifer by the output of a single-channel analyser, is monitored by a light dependent resistor (L.D.R.). The resistance of the L.D.R. varies with the count rate. In series with the L.D.R. is a scanning secondary incandescent bulb. The brightness as well as the frequency of the flashes of the latter vary with the count rate and thus a non-linear response is obtained without the introduction of the inertia of a ratemeter circuit. The secondary flashes are recorded on film. To prevent loss of information by registering in the saturation region of the film-sensitivity curve, a moderate contrast-amplification is used and the film is viewed on a closed-circuit television system. The necessity is stressed for adapting the collimation to the clinical problem to be solved. Clinical applications of the above technique in the study of diseases of the thyroid, kidneys, liver, and the skeleton are discussed. (auth)

17755 AN AUTOMATIC SCANNING SYSTEM, USING A TAPE PERFORATOR AND COMPUTER TECHNIQUES. H. Schepers and C. Winkler (Universitat, Bonn). p.321-30 of STI/PUB/82(Vol. I).

The choice of scan velocity and spacing is purely a statistical problem, provided that the other parameters are determined. In the scanning devices commonly in use (detectors moving with constant velocity) optimum statistical conditions cannot, however, be predetermined. Therefore, the quantitative evaluation and the visualization of a non-uniform distribution of radioactivity can be improved. In order to solve the problems mentioned above, a new scanning device was developed. The object is scanned, with preset count, point by point, and therefore the statistical error is determined. Thus, the degree of accuracy appropriate for each case can be chosen at the beginning of the scan. The scanning time is then exactly that which is determined by the selected degree of accuracy, no more and no less. The data, including the co-ordinates of detector position and timing are recorded by a tape perforator and the paper tape is fed into a digital computer. The computer program undertakes the following steps: calculation of the pulse rate for each point, subtraction of background and, if needed, correction for radioactive decay; least-squares approximation prevents statistical deviations of the single counts from influencing the evaluation of the final result. This is plotted by the computer in such a manner that any person not specially trained is easily able to plot a series of isocount curves. After evaluation of the plot, further quantitative calculations can be performed by the computer using an appropriate programme. In a more sophisticated set-up, two probes with different collimators are used simultaneously, one with an aperture providing high resolution and the second one with poor resolution but high efficiency. The latter serves as an indicator giving a quick decision. The count rate is significantly increased when compared with the background. By using this equipment it is possible to reduce considerably the time necessary for the performance of the scan. (auth)

17756 TWO NEW TYPES OF DETECTOR FOR X- OR GAMMA-RAY CAMERAS. C. Kellershohn, A. Desgrez, and A. Lansiart (Centre d'Etudes Nucleaires, Saclay, France). p.333-54 of STI/PUB/82(Vol. I). (In French)

X- or γ-ray cameras consist essentially of a hole-type or grid-type lens system together with a detector. Two kinds of detectors are described that are quite different from the Anger device, which so far has been the only one in practical use. The first consists of a self-triggering spark chamber. This chamber, about 20 cm in diam. and filled with a rare gas (argon or xenon), forms a cathode and two grids. The cathode and the second grid are subjected to a potential difference of several kilovolts, somewhat lower than the breakdown voltage. The first cathode-grid space serves as an electron source under the action of the low-energy x or γ ray photons. The cathode can also be plated with a metal of high Z, or a crystal scintillator connected to a photocathode can be used. After suitable amplification, the sudden burst of charges due to electron multiplication in the Townsend avalanche produces a well localized spark with a delay of a fraction of a microsecond. The image is obtained with the aid of a camera whose shutter is permanently open. The second type of detector consists of a

CsI(Tl) crystal connected to the photocathode of a Thomson tube, 20 cm in diam. and with electrostatic focusing. The image on the secondary screen of this tube is transferred by an optical device to the photocathode of a tube with parallel electric and magnetic field and serving as shutter. Some of the light entering the optical device is received by a photomultiplier, which controls the opening of the shutter tube through an amplitude selector. This arrangement makes it possible to distinguish between the light due to the signal and that due to the noise of the Thomson tube. The shutter tube is opened only by the former. Since the shutter tube remains open for only an extremely short time, the signal-noise ratio of this detector arrangement is high enough to give an image on the end screen of the shutter tube using a permanently open camera. The characteristics of these two types of detectors and the preliminary results obtained are discussed. (auth)

17757 STUDY OF A SCINTILLATION CAMERA: DESCRIPTION AND CLINICAL APPLICATION. H. Jammet (Fondation Curie, Paris), J. Morichere, and P. Desneiges. p.355-75 of STI/PUB/82(Vol. I). (In French)

The spatial distribution of radioactivity within an organ is at present studied routinely with the aid of mobile detectors capable of examining different points in the organ one after the other by means of scanning. In recent years efforts have been made to construct fixed detectors which are able to explore all the points within an organ simultaneously. The design and operation of an apparatus in which a single crystal is viewed by a number of photomultipliers are described. The main components of the apparatus include a detector head consisting of a crystal and 7 photomultipliers, plus a conical chamber fitted with a diaphragm or a grid; devices for localizing scintillations in the crystal and for pulse selection; and recording equipment consisting of two cathode-ray oscilloscopes fitted with a camera; one of which is equipped with a remanence memory tube. Results obtained in exploring various organs, general information on the technique, and a number of novel applications are included. (auth)

17758 DYNAMIC STUDIES WITH A GAMMA-RAY SCINTILLATION CAMERA. W. G. Myers (Ohio State Univ., Columbus). p.377-90 of STI/PUB/82(Vol. I).

A commercial model γ-ray scintillation camera was used to study dynamic physiological and pharmacological processes in vivo. The 0.6 × 20-cm NaI crystal is viewed by 19 multiplier phototubes. Light flashes generated in this plate by γ-rays are caused electronically to appear as small coruscations in the same relative positions on an oscilloscope screen. A Polaroid camera focused on this screen gradually forms a picture, the spatial densities of which represent the spatial distribution of γ-rays projected from the biological object into the collimating system. Either a 5-mm diam. pinhole or a 771-hole multi-aperture lead collimator is used to view an area of about 16-cm maximal diameter. This ingenious instrument makes true point-by-point scans electronically. The pictures have no line structure to distort perception. No mechanical difficulties are possible. The ability to view the entire area of interest continuously during a scanning seance is advantageous in reducing the dosage of radioactivity and the statistical errors. A unique feature is the opportunity provided by this camera to make pictures in fast sequence to record rapid changes in the distribution of γ-isotopes. A maximum rate of three pictures each minute has been achieved with 10-s Polaroid roll film. Motion-picture apparatus would provide even higher rates when required to record movements in extraordinarily fast processes. After ^{131}I-iodide was injected intravenously into a rat, a series of pictures, taken during the first 2 min of six successive 5-min intervals, revealed rapid disappearance of the radioiodine initially distributed throughout the whole body, and concentration in the stomach region within 30 min. Most of the radioactivity remained localized there during the remaining 7 h of the experiment, at which time only a modicum had accumulated in the thyroid. Similarly, after subcutaneous injection of ^{131}I-orthoiodohippurate into a rat's supraclavicular region, the camera revealed migration into the kidneys within 3 min, into the bladder in 5 min, and complete clearance into the bladder in 90 min. Larger prototype scintillation cameras have been manufactured recently that incorporate 1.3 × 30-cm crystals. (auth)

17759 A SCINTILLATION CAMERA FOR KINETIC STUDIES OF THE DISTRIBUTION OF RADIOACTIVE NUCLIDES IN THE BRAIN. W. Gross, E. B. Schlesinger, and S. De Boves (Columbia Univ., New York). p.401-10 of STI/PUB/82(Vol. I).

A scintillation camera specifically designed for the study of the kinetics of the distribution of radioactive nuclides in the brain was developed. This device employs two banks of ¾ in. × 1 in. sodium iodide-thallium activated crystals, 63 crystals per bank arranged in a 7 × 9 close-packed array on 1-in. centres. These banks can be placed so that both lateral views or one lateral and one P-A or A-P view can be obtained simultaneously. The field of view of each crystal is limited by a collimator consisting of nineteen tapered holes whose axes are all parallel. This design gives a response of nearly equal full-width at half height to a simulated tumour source at all distances up to 4 in. from the front of the collimator. This response is sufficiently wide to avoid significant dead areas and yet narrow enough to permit accurate observation of the activity distribution within a very few minutes using normal tracer doses of iodine-131. Each crystal is optically coupled to its own photomultiplier in an integral package. The output pulses of the photomultipliers are analysed by discriminators and the information stored in digital form in a quarter of the memory of a 512-channel pulse-height analyser. Time coincident pulses from the various detectors can be accepted by this equipment so that losses are negligible. Read-out in several forms is available. In digital form either a typewritten record or punched paper tape can be obtained. The latter may be read back into the equipment for review. Analogue read-out is made on a large screen oscilloscope. The scope beam is defocused and two 63 point display rasters generated to correspond to the spatial location of the scintillation counters. Intensity modulation of the oscilloscope beam as well as background erasure is used to assist in visualizing the activity distribution. (auth)

17760 AUTOFLUOROGRAPHY WITH AN X-RAY IMAGE AMPLIFIER. M. M. Ter-Pogossian and J. O. Eichling (Washington Univ., St. Louis). p.411-20 of STI/PUB/82 (Vol. I).

The visualization of organs containing radioactive isotopes emitting x or gamma-ray photons with energies between 20 and about 100 kev can be achieved by converting the radiation emerging from the organ into light by means of an x-ray image amplifier of conventional design. The apparatus designed for this purpose consists of a collimator, the specifications of which are determined by the resolution and by the operating distance desired; an electrostatic focusing x-ray image amplifier, which converts the collimated x- or gamma-ray photons into an optical image of high brightness; and a large aperture lens system which projects the image into a Polaroid camera loaded with fast, high-contrast film. The performance of this apparatus for low-energy photons is superior to that of conventional scintiscanners. The usefulness of this apparatus for the visualization of brain tumors, kidneys, and the thyroid gland is discussed. (auth)

17761 AN ANALYSIS OF QUANTITATIVE COLOUR DISPLAY FOR SCANNING. J. R. Mallard, M. H. Duggan, M. J. Myers, and R. J. Wilks (Dept. of Medical Physics, Hammersmith, London). p.423-49 of STI/PUB/82(Vol. I).

In color scanning, color is used to present quantitative information in the display. Six colors are used for six equal divisions of count-rate across a ratemeter scale. In high count-rate scans (>50 cps) the statistical spread of count-rate is small and the eye can see bands of color on a scan and perceive boundaries between colors, these boundaries being isocount lines. In low count-rate scans (<5 cps) the larger statistical spread results in overlap and marks appearing in the neighbouring colors. The relative proportion of marks in neighbouring colors can be calculated for a

given count-rate and compares well with observation. Although isocount lines can no longer be perceived at these low count-rates, the color changes between target and non-target areas lead to visual perception of differences in count-rate as low as one standard deviation; this is below that possible with monochrome printing without background suppression. A recent modification to improve the visual contrast still further has been to make the width of the mark, as well as the color, change with count-rate. Several other methods of color scanning have been developed by other workers. Having established the lowest limit of count-rate difference which can be detected (approximately one standard deviation) it is possible to use a very simple phantom using disc tumors 1 cm thick, from which predictions can be made of the smallest size of any shape of tumor which can just be perceived at any concentration ratio and depth. Figures are given for the color display used with a long-focusing depth-independent collimator. It is shown that 2.5 cm cylinders at a depth of 12 cm can be perceived at 8 : 1 concentration ratio. (auth)

17762 EXPERIENCE WITH A NEW COLOR-SCINTILLOGRAPHIC METHOD FOR DIAGNOSING LIVER TUMORS AND INFLAMMATORY LIVER DISORDERS. T. Sparchez, B. Gheorghescu, A. Steclaci, E. Merculiev, and M. Popovici (Clinique Medicale, Bucharest). p.473-90 of STI/PUB/82 (Vol. I). (In French)

In order to obtain a better picture of the structural details of the diseased parenchyma of the liver, a device was developed for use with the Scanner-Tracerlab which produces liver scans made up of seven colors. The colors are chosen arbitrarily, each one corresponding to a given number of counts and representing zones of isoradioactivity, i.e. zones of liver tissue of relatively equivalent volume. The white in these color scintigrams represents the radiation background and the black corresponds to the peak activity in the center of the liver, where the parenchyma is thickest. The colors in between correspond to the different zones of isoradioactivity. This method was used to examine 150 patients suffering from malignant (primary and secondary) and benign tumors, patients suffering from chronic hepatitis and cirrhosis, and 50 normal subjects. In most of the cases studied, intravenous injections of colloidal gold-198 were used. In numerous cases parallel studies were carried out with mechanical scans, black-and-white photoscintigrams and color scintigrams. Diagnoses were checked by means of punctures, laparoscopy, laparophotography, or cinematography, biopsic punctures, surgery, and necropsy. Color scintillography brings out more clearly the variations in the intensity of the radioactivity, i.e. the disorganization of the parenchyma of the liver or its substitution by tumoral processes. (auth)

17763 ELECTRONIC MODIFICATION OF THE SCINTIGRAM AND ITS LIMITATIONS. B. Conrad and W. Horst (Cantonal Hospital, Zurich). p.491-507 of STI/PUB/82(Vol. I).

An investigation of the basic principles of contrast enhancement is presented. Certain fundamental laws are discussed that should be observed in the design of transforming systems as well as in their application in order to visualize a maximum of information. An apparatus is described in detail which gives an optimum of linear presentation using a suitable selected non-linear transforming function. Thus the range of net counting rate between background and maximal counting rate is projected to the full range of blackening in the scintigram in a manner that provides a minimum of falsification of data. Also other kinds of presentation can be selected, for example various quasi-logarithmic characteristics. The problem of contrast enhancement in the case of extremely small differences, for example in brain-tumor scanning, is discussed in detail. The principles described could be applied not only to scanners, but also to stationary detectors of every kind. (auth)

17764 ANALYSIS OF SCAN RECORDS WITH A RECORDING DENSITOMETER— THE "RE-SCANNER." C. C. Harris, P. R. Bell, M. M. Satterfield, D. A. Ross, and J. C. Jordan (Oak Ridge National Lab., Tenn.). p.529-43 of STI/PUB/82(Vol. I).

The impact of improvements in scanning equipment has not been fully felt at the clinical level, largely because of deficiencies in scan recording. In an attempt to improve visualization and contrast in scan records, various instrumental methods of analysis have been devised. A simple and comparatively inexpensive recording densitometer for re-scanning scan records is described. A light-sensor scans the record just as a scanner scans a patient. The output of the device is a pulse rate proportional to the opacity (or transmission) of the record, and may be used to make a new, or re-scan, record. The area of the record over which information is integrated is set by sensor aperture. The wide range of output pulse-rates (zero to 15,000 parts/s) causes large and adjustable contrast amplification. A threshold control provides any cut-off level of choice. Operation is rapid, and a record can be re-scanned in a small fraction of the time required to obtain the original record. Studies on clinical scans of almost every organ or area of interest show that the re-scanner reveals information not at first evident in original scan records. It has been particularly useful in determining the statistical significance of small variations in counting rate in a scan record. In scan records of large dynamic range where no single cut-off level satisfactorily shows all regions of interest, re-scans at several cut-off levels were once necessary. A two-region sensor, that views a region of the record around the field of view of the main sensor, has been used in an attempt to overcome this difficulty. At least three modes of operation are possible with the two-region sensor: normal operation; ignoring general record density and responding only to small variations, thus setting its own cut-off level; and reporting only abrupt changes in record density. Other modes seem to be possible. This relatively simple and inexpensive device is proving to be of valuable assistance in the interpretation of scan records. (auth)

17765 PROSPECTS FOR THE USE OF A NEW SYSTEM OF INTENSIFIED CONTRAST RECORDING. I. Baschieri and A. Scognamiglio (Universita, Rome). p.545-57 of STI/PUB/82(Vol. I). (In French)

The normal recording systems used to give a scintigraphic image are not capable of yielding sufficient contrast for the identification of two radioactive zones when the difference in concentration of the radioisotope is less than 20%. The technical procedures adopted by different writers in order to get more exact information from scintigraphic examinations and the advantages and disadvantages of each of these procedures are discussed. A new technical solution of the problem is proposed that consists in varying the width and height of each mark in relation to the time between two successive marks, not to the average pulse frequency. The recording element is controlled electronically. The circuit presented examines precisely the time interval between one pulse and the preceding one and produces a pulsating voltage which varies with the separation of the pulses. This pulsating voltage selectively controls the recorder. In this way variation of the recorded mark is obtained. The new system makes it possible to obtain adequate contrast between radioactive zones with a difference of activity of about 10%. The first experimental results are given. (auth)

CHEMISTRY

General

17766 (NP-14811) BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF MATERIALS IN THE CONDENSED STATE. October–December 1964, Volume 1964, Number 4. J. J. Diamond, ed. (International Union of Pure and Applied Chemistry). 59p.

Over 600 references are presented on the following topics: devices for achieving, measuring, and controlling temperatures above 1500°C; devices for physical measurements above 1000°C; properties below and above 1000°C of materials melting above 1500°C; properties above 1000°C of materials melting above 1500°C; phase equilibria; and reactions above 1000°C. (D.L.C.)

17767 (ORNL-TM-1045) TECHNIQUES FOR ASSESSING REMOVABLE SURFACE CONTAMINATION. George W. Royster, Jr., and Birney R. Fish (Oak Ridge National Lab., Tenn.). Feb. 4, 1965. Contract [W-7405-eng-26]. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A study was initiated to investigate the methods of measurement and the factors controlling the dispersal of surface contaminants. Thorium dioxide dust is allowed to settle on test surfaces, and the redispersible contamination is sampled by means of a wipe test, by applying adhesive papers, and by using a procedure which employs air impingement to remove loose contamination from the surface. Test surfaces include glass, concrete, floor tile, stainless steel, aluminum, fiberboard, and other common laboratory materials. Studies of contamination sampling indicate that the wipe and the adhesive paper methods are strongly affected by the physical condition of the surface, the concentration of the contaminant, and variations in technique between different monitoring personnel. Air impingement sampling has been found to be essentially independent of surface roughness and dusts and results in minimal variation between different monitoring personnel; redispersion efficiency varies with particle size of the contaminant and with velocity of the air impinging on the surface. (auth)

17768 (TID-21330) EXPERIENCES IN BLENDING FOR ISOTOPIC ADJUSTMENT. W. E. Shaw (National Lead Co. of Ohio, Cincinnati). Oct. 12, 1964. Contract AT (30-1)-1156. 20p. Dep.; $1.00(cy), 1(mn) CFSTI.

Data which pertain to blending for isotopic adjustment have been collated from the experiences of the Y-12, Oak Ridge Gaseous Diffusion Plant, and Paducah Divisions of Union Carbide Corporation Nuclear Division and the Feed Materials Production Center operated by the National Lead Company of Ohio. Analyses indicated that successful isotopic adjustments were accomplished in blending solids when a large enough portion of the resultant blend was homogenized prior to analysis. Liquid-liquid blending either by solution, molten salt, molten metal, or reduction-to-metal techniques resulted in blends that were homogeneous within the limits of analysis. The techniques involving liquid-liquid blending are preferred to obtain an isotopically uniform product. (auth)

Analytical Procedures

Refer also to abstracts 17850, 18079, 18145, 18147, and 18153.

17769 (CEA-Bib.-50) L'ANALYSE PAR ACTIVATION AUPRES DES ACCELERATEURS DE PARTICULES. (Activation Analysis with Particles Accelerators). Micheline Berton (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Dec. 1964. 125p. Dep.(mn).

A total of 1210 references is presented in three sections dealing with particle accelerators and portable neutron generators, analysis of elements and materials, and applications of activation analysis. Report number, author, and section indexes are included. (D.L.C.)

17770 (CEA-R-2709) DOSAGE DU STRONTIUM 90 DANS LES CENDRES D'OS HUMAIN. (Determination of Strontium 90 in Human Bone Ashes). Francois Patti and Lucien Jeanmaire (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre d'Études Nucléaires). Jan. 1965. 16p. Dep.(mn).

A procedure is described for the determination of ^{90}Sr in bones by dosage of its daughter product ^{90}Y. The method includes elimination of the phosphate ions by precipitation of the Ca and Sr as oxalate in the presence of acid; reduction of the Ca concentration to a suitable level by the addition of a known volume of nitric acid (a single precipitation is sufficient); the precipitation yield of the Sr nitrate is checked by the measurement of the amount of ^{85}Sr added as tracer; purification by a yttrium hydroxide precipitation; and extraction at equilibrium of the ^{90}Y which is counted to give the ^{90}Sr concentration. By using 50 g of ash it is possible to detect about 0.1 pC of $^{90}Sr/g$ of Ca. (C.H.)

17771 (CRDC-1212) DETERMINATION OF HYDROGEN IN ZIRCONIUM ALLOYS BY ISOTOPIC EQUILIBRATION. R. W. Ashley and A. S. Denovan (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1965. 8p. (AECL-2202). Dep.; $0.50(AECL).

A method is described for the determination of hydrogen in zirconium alloys by equilibration of a sample with deuterium gas at an elevated temperature and measurement of the resulting isotopic dilution by mass spectrometry. The method is rapid and simple. The precision and accuracy over a wide range of sample size and hydrogen concentration are equal to those obtained by vacuum extraction or fusion methods. Comparative results are given for standard samples. (auth)

17772 (EUR-2165.i) STUDIO SULL' APPLICAZIONE DI METODI ELETTROCHIMICI IN ANALISI PER ATTIVAZIONE. (Application of Electrochemical Methods to Neutron Activation Analysis). C. Bigliocca, F. Girardi, and J. Pauly (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Feb. 1965. 15p. Dep.(mn).

The application of electrochemical methods to neutron activation analysis was studied, with particular reference to controlled potential deposition and spontaneous deposition on mercury amalgams. Different factors which influence these processes were considered. Electrochemical techniques were then applied to problems of interest in neutron activation analysis: zinc-cadmium and copper-antimony separations, trace analysis of aluminum, determination of antimony in presence of copper, removal of a highly active copper matrix. (auth)

17773 (EUR-2219.e) OPTIMAL CONDITIONS FOR MASS SPECTROMETRIC QUANTITATIVE DETERMINATIONS BY ISOTOPE DILUTION. P. J. De Bievre and G. H. Debus (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center and European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Jan. 1965. 42p. Dep.(mn).

Formulas are presented for the calculation of: (1) a quantity determined by isotope dilution; (2) the effective precision on this quantity; (3) an a priori estimation and graphical presentation of the attainable precision on the quantity, allowing optimal choice of spike and mixing ratio. The mathematical treatment is based on the normal propagation of statistical errors. (auth)

17774 (GEAP-4490) ELECTRON BEAM MICROPROBE STUDIES OF THE OXIDATION BEHAVIOR OF THE IRON–CHROMIUM–NICKEL SYSTEM IN HIGH-TEMPERATURE STEAM. I. TRACE INTERPRETATION TECH-

NIQUES. E. G. Brush (Vallecitos Atomic Lab., General Electric Co., San Jose, Calif.). Mar. 1964. Contract AT (04-3)-189. 57p. Dep; $3.00(cy), 2(mn) CFSTI.

A technique was developed for the interpretation of microprobe data on the oxidation of Fe–Cr–Ni alloys. Type 304 stainless steel, Incoloy-800, Inconel-600, and Hastelloy-X exposed to steam at 1050 and 1300°F, were used in the development. X-ray source areas, standard oxide-phase morphological models, and mathematical models were studied. (D.L.C.)

17775 (HNS-1229-57) A RADIOACTIVE XENON ANALYTICAL FACILITY. W. R. Schell and C. L. Carnahan (Hazleton-Nuclear Science Corp., Palo Alto, Calif.). Jan. 26, 1965. Contract AT(29-2)-1229. 30p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

An analytical facility for measuring radioactive xenon in air samples has been set up. The facility consists of a gas separation system, which effectively removes air, krypton, and radon from xenon, and a low-level gas counting system. The xenon activity is measured in low-level, internally filled detectors. The gas separation method employed is based on an earlier design by Momyer, in which an air sample is condensed on liquid nitrogen cooled charcoal traps, and then selectively eluted during warming while helium carrier gas is passed through the traps. A gas chromatography preparative column filled with molecular sieve is used in the final purification step. The elution progress is determined by two thermal conductivity cells. Recovery of xenon from ~100 S.C.F. of air sample is better than 94%, and effective decontamination from krypton and radon is achieved. Decay characteristics of ^{131m}Xe, ^{133}Xe, ^{133m}Xe, and ^{135}Xe are discussed with reference to ^{133}Xe measurement in internally filled detectors. Eight 56-cm^3 detectors were designed to enable xenon to be condensed in a cold finger, and methane counting gas to be added to one atmosphere total pressure. The detectors were inserted between two lead shielded guard detectors, which were designed for anticoincidence planchette counting. The detectors have anticoincidence backgrounds of from 2.5 to 4.2 cpm and efficiencies for ^{133}Xe of 70 to 82 percent. The facility is capable of analyzing one 100 S.C.F. air sample in nine hours, and each sequential sample in an additional five hours. (auth)

17776 (HW-48815) DETERMINATION OF PHOSPHORUS IN ALUMINUM CORROSION PRODUCTS. R. Ko (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Feb. 28, 1957. Contract W-31-109-eng-52. 4p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An emission spectrographic method was applied to the determination of phosphorus in aluminum phosphate—aluminum oxide mixtures. The sample is analyzed directly by d-c arc excitation using gallium as the internal standard. The precision of a single measurement is ±12% (at the 95% confidence level) in the range from 0.5 to 25% phosphorus. (auth)

17777 (IS-1117) THE DETERMINATION OF TRACE AMOUNTS OF TANTALUM AND TUNGSTEN IN METALS. A. F. Voigt, G. L. Jewett, E. C. Jacobson, K. L. Malaby, and J. D. Woods (Ames Lab., Iowa State Univ. of Science and Tech.). Mar. 1, 1965. Contract W-7405-eng-82. 17p. (CONF-650405-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Conference on Modern Trends in Activation Analysis, College Station, Tex.

Neutron activation analysis was applied to the determination of tantalum and tungsten in thorium and of tantalum in yttrium with success. Two procedures were developed for the determination of tantalum in thorium using ^{182}Ta, one using chemical techniques and the other a simple method of absorbing interfering radiation. The chemical method was designed particularly to remove ^{233}Pa. The determination of tantalum in yttrium metal is done by a chemical method involving the addition of a solution of tantalum carrier in HNO_3, HCl, and HF to the yttrium sample in HCl. This step precipitates YF_3, and traces of yttrium are removed with a Dowex-50 column. Tantalum is precipitated and counted as the hydrated oxide. A method was developed for determining tungsten in thorium which uses the insolubility of tungstic oxide in acidic solutions and its solubility in base to separate it from Th and Pa which precipitate or are absorbed on an anion exchange column from a basic solution. (D.L.C.)

17778 (LA-3097) THE GRAVIMETRIC DETERMINATION OF RHODIUM IN URANIUM–RHODIUM ALLOYS. Ross D. Gardner and William H. Ashley (Los Alamos Scientific Lab., Univ. of California, N. Mex.). May 1964. Contract W-7405-eng-36. 10p. Dep.; $0.50(cy), 1(mn) CFSTI.

A gravimetric method in which rhodium is reduced to the metallic state by magnesium has been modified and applied to the determination of rhodium in uranium–rhodium alloys. The precipitate of rhodium metal is placed in a porcelain boat, which is transferred to a standard quartz combustion tube, where the rhodium is heated in a stream of hydrogen at approximately 1000°C. The analysis of 58 known solutions simulating uranium–rhodium alloys containing from 0.5 to 10 percent rhodium showed an average recovery of 100.05 percent with a relative standard deviation of 0.7 percent for a single value. (auth)

17779 (LA-3152) THE SPECTROPHOTOMETRIC DETERMINATION OF TRACE AMOUNTS OF NICKEL IN TANTALUM METAL. Ross D. Gardner, Carter H. Ward, and William H. Ashley (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Sept. 1964. Contract W-7405-eng-36. 10p. Dep.; $1.00(cy), 1(mn) CFSTI.

The spectrophotometric method for the determination of nickel by use of dimethylglyoxime has been modified and applied to the determination of trace amounts of nickel in tantalum metal. In this method, the tantalum is dissolved in a mixture of hydrofluoric and nitric acids and is kept in solution with citric acid after removal of most of the hydrofluoric acid by gentle heating. Interference from any remaining hydrofluoric acid is eliminated by complexing it with boric acid. The analysis of 45 known solutions containing from 5 to 100 micrograms of nickel and 0.2 to 1 gram of tantalum showed an average recovery of 100.1 percent with a standard deviation of 1.4 percent of the nickel present. (auth)

17780 (KY-481) PURITY DETERMINATION OF A URANIUM METAL STANDARD. B. H. Whiteaker, J. C. Gillespie, and P. E. Dill (Paducah Gaseous Diffusion Plant, Ky.). Mar. 1, 1965. Contract W-7405-eng-26. 29p. Dep.; $2.00(cy), 1(mn) CFSTI.

High purity uranium metal is evaluated for use as a standard sample. Samples in the form of 5-gram metal cubes, obtained from a regular high purity production run prepared by the magnesium bomb reduction method, were submitted by the Paducah Gaseous Diffusion Plant to the laboratories of the Oak Ridge and Portsmouth Gaseous Diffusion Plants, and the Y-12 Plant at Oak Ridge. The purity of the metal was established by analyzing for the impurities and subtracting them from 100. A compilation of the data received resulted in a tentative purity value of 99.9865% ± 0.0043%. Analyses of the five elements not included indicated a possible additional impurity content of as much as 300 ppm. However, there is every reason to believe that they should be entirely absent. Therefore, this value has been assigned to the metal and will be used as the reference standard in the resolution of analytical differences between laboratories. (auth)

17781 (ORNL-3750) ANALYTICAL CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING NOVEMBER 15, 1964. (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 144p. Dep.; $5.00(cy), 3(mn) CFSTI.

A prototype controlled-potential d-c polarograph-voltammeter was designed and constructed; solid-state instead of vacuum-tube operational amplifiers and power supplies are used. To facilitate the evaluation of d-c polarographic instrumentation, computer programs were written. These programs solve the Koutecký equation for a value of the diffusion coefficient and provide computer-plotted, normalized, theoretical curves (simple reversible diffusion-

controlled process) for the regular polarographic wave and for the first-, second-, and third-derivative waves. Two ORNL model Q-2564 high-sensitivity coulometric titrators were fabricated and installed. A check-out and test procedure and a troubleshooting guide were prepared. A paper that described the application of the derivative method to stationary-electrode voltammetry with linearly varying potential was presented at the 148th American Chemical Society Meeting. The accuracy and reproducibility of first-derivative linear-sweep voltammetry are about the same as those of regular linear-sweep voltammetry; the sensitivity is at least an order of magnitude greater. A safety circuit for the multiplier phototube of the ORNL model VII flame spectrophotometer was designed and installed; the circuit has twice provided automatic shutdown that saved the phototube. Study of the reference electrode in controlled-potential coulometry was continued with the $Bi^{3+}-UO_2^{2+}$ system. The development of analytical instruments necessary to the MSRE and TRU programs was continued. Several remotely operated instruments for use in hot cells were redesigned to simplify manipulation and maintenance. Absorption spectrophotometric studies of various molten-salt systems were continued. The atmosphere of the Ni high-temperature spectrophotometric cell assembly was freed from water, O_2, and HF by placing chips of Ti sponge in the sample compartment. This procedure resulted in the stability of the absorption spectrum of U^{4+} in LiF–NaF–KF for 15 hr. The absorption spectrum of U^{3+} at 500°C in LiF–BeF_2–ZrF_4 was obtained by reduction of U^{4+} by either Zr or U metal. The molar absorptivity of the strongest U^{3+} peak at 875 mμ in the near-infrared region was estimated to be 40 liters $mole^{-1}$ cm^{-1}. In the ultraviolet region, at 360 mμ, the molar absorptivity is about 500 liters $mole^{-1}$ cm^{-1}. The spectrum of U^{3+} in LiF-BeF_2 appears to be identical with that in LiF-BeF_2-ZrF_4. A special holder for very small crystals was devised to obtain spectra from 280 to 750 mμ of crystals whose diameter is of the order of 0.1 ma. The absorption spectrum of UF_6 was obtained using a vacuum-tight fluorinated-Ni gas cell equipped with crystalline Al_2O_3 windows and Teflon gaskets. The spectrum is complex in the region 340 to 420 mμ with a maximum at 368 mμ, at which wavelength the molar absorptivity of UF_6 is 5.5 liters $mole^{-1}$ cm^{-1}. The experimental equipment used to investigate the electroanalytical characteristics of molten-fluoride salt systems was modified to eliminate possible contamination from moisture. With this equipment the decomposition potentials of such metals as Zr, Cr, Fe, Ni, and Mo in molten fluorides were obtained. Rapid-scan and anodic-stripping voltammetry of Ni in molten LiF-NaF-KF were studied. By means of the anodic-stripping technique, as little as 1 ppm of Ni can be measured in the melt. Voltammetry was also applied to the MSR coolant in fuel salts. The presence of Hf was indicated by these studies. Further studies were also carried out in an effort to determine chromium in the fuel salt. Work was continued on the development of a reference electrode that would be compatible with molten-fluoride salts. The study of the effect of ^{60}Co gamma radiation on the reaction of Ni with dimethylglyoxime (I) was completed. A postirradiation effect on the Ni-I complex was noted in that the color of the complex returns after it has been removed from the source of radiation. The radiation damage to the colored complex is apparently due to reduction of the Ni(III) in the complex. A detailed study of the effect of gamma radiation on the determination of U(VI) in phosphoric acid solutions of uranium(IV) oxide was completed. Errors due to radiation can be minimized by excluding O_2 from solutions of UO_2 and by maintaining the UO_2 concentration as low as possible. Studies of the effect of gamma radiation on hydrochloric, sulfuric, phosphoric, and acetic acid solutions of arsenazo III were completed. Similar studies of 2-thenoyltrifluoroacetone (TTA) were initiated. Studies were also initiated on the radiolysis of solutions of high chloride concentration. For the GCR, evaluation of various types of detectors in the gas chromatographic determination of impurities in helium was continued. For TRU, the effort is to provide methods of analysis needed to control the process being carried out at ORNL. Radiochemical, instrumental, and ionic methods are under investigation. A gas chromatograph was designed for the analysis of corrosive gases such as nitrogen dioxide, dinitrogen trioxide, chlorine, and nitrosyl chloride. The use of Ta appears to provide the necessary corrosion-resistant material. Gas chromatography was used to analyze aliphatic diluents used in solvent-extraction processes. The Ar-beta ionization detector was successfully applied to this problem. The combustion-gas chromatographic determination of organic C in aqueous and HNO_3 solutions was studied further in an effort to increase the recovery of known amounts of organic C. The sealed-tube dissolution technique was applied with limited success to a variety of difficulty soluble compounds such as graphite-coated UO_2, carbides, and several organic compounds. In general, the perchloric acid technique is more successful for the dissolution of fluidized coke or graphite-coated materials. The horizontal-orifice Teflon dropping-mercury electrode (D.M.E.) was used to obtain fundamental polarographic data for the $Tl^+ \rightleftharpoons Tl^0$ reaction in 0.1 M KCl – 1 mM HCl and the $Pb^{2+} \rightleftharpoons Pb^0$ reaction in 1 M HCl. The data obtained are interchangeable with those taken with glass D.M.E.'s. The horizontal-orifice Teflon D.M.E. was also used to determine for the first time the polarographic characteristics of the $Pb^{2+} \rightleftharpoons Pb^0$ reaction in HF solutions of concentrations from 1 to 12 M. A procedure was developed for fabricating a vertical-orifice Teflon D.M.E. A study of the chronopotentiometry of Pu in mineral acid media was completed. Diffusion coefficients of the different Pu species were measured, and possible analytical usefulness of chronopotentiometry for the determination of Pu was evaluated. Studies with 10 M LiCl solutions showed that the free-acid concentration of such solutions can be determined in the presence of hydrolyzable cations by direct titration without the addition of complexing agents. The investigation of solid indicator electrodes made of pyrolytic graphite and glassy C was continued to determine their applications and limitations. An apparatus using flame ionization detection was developed to measure total concentration of organic contaminants in the atmosphere of reactor-fuel-burnup test assemblies. Hydrocarbon concentrations equivalent to 5 ppb of CH_4 in air can be detected. Modifications were made to the apparatus for the determination of O_2, C, and H_2 in alkali metals. Some of these modifications were required to determine both O_2 and H_2 in the same sample. A microtitration cell that does not require an interval electrode was fabricated of pyrolytic graphite for potentiometric titrations of highly radioactive solutions. In a program to recover and separate ribonucleic acids (t-RNA's) from Escherichia coli bacteria efforts are concerned with modifying procedures to reduce the overall time required for analysis. The analysis of powdered solids was investigated by the x-ray absorption-edge method with a rotating sample holder. Disposable one-piece polystyrene cells were fabricated for use in the analysis of radioactive solutions by the same method. Computer codes were written for determining the height of an x-ray absorption edge by extrapolation and for analyzing multicomponent alloys by x-ray fluorescence. Ru and Se were determined at the 0.5-μg/ml level by atomic absorption with an air-H_2 flame and an end-fed absorption tube. A procedure was developed for separating traces of Ba from the alkali metals, alkaline-earth elements, and other elements by coprecipitation on lead chromate. The Ba is subsequently determined by flame photometry. The new double-magnetic-deflection mass spectrometer was put in service in a laboratory arranged for containment of alpha radioactivity. Ion detection is by secondary electron multiplier, and pulse counting is used instead of current measurement. Only 1 to 2 ng of sample is required; rare isotopes in concentration as low as 1 ppm can be measured. The isotopic composition of atmospheric Ne was measured by use of ^{20}Ne and ^{22}Ne standards of high isotopic and chemical purity; the composition (atom percent) is indicated to be: ^{20}Ne, 90.514 ± 0.031; ^{21}Ne, 0.266 ± 0.005; ^{22}Ne, 9.220 ± 0.029. Infrared spectroscopy was used to determine the effect of gamma

radiation on such compounds as butyl-α-methylbenzylphenol, 2-thenoyltrifluoroacetone, dimethylglyoxime, sodium dimethylglyoxime, o-benzylphenol, di-sec-butylphenylphosphonate, ion-exchange resins, and fractions of the products from the HNO_3 degradation of diethylbenzene. Infrared absorption spectra were measured for the water-soluble acidic solids and ether-soluble waxes that are the products of the hydrolysis of U carbides and Th carbides with water or HNO_3. Semiquantitative or quantitative determinations were made of a number of compounds. Studies were made of particulates from simulated fallout experiments in connection with the Nuclear Safety Program. The Philips EM 200 electron microscope was installed; resolution of the order of 6 Å or better has been achieved with it. An electron microscopical study was made of the effect of cationic surfactants on the structure of thoria sol-gel beads. The examination of the ultrastructure of certain exchange resins was begun. Vapordeposited thin metallic films were made. Branching-ratio measurements and decay-scheme studies were made on ^{141}Ce, ^{79}Kr, ^{99}Mo-^{99m}Tc, and a new isomer, ^{82m}Br. A study of successive neutron-capture reactions on La and Ce was begun. A search for new alpha emitters resulted in the discovery of alpha emission in ^{148}Eu. Nuclear levels were studied in a number of even-A nuclei, and neutron-deficient hafnium radionuclides produced in ORIC by (α,xn) reactions were investigated. The use of Li-drifted Ge diodes for such decay-scheme studies and the effect of spectrometer live time on precision were evaluated. An IAEA ^{137}Cs standard intercalibration was done, and the absolute determination of ^{125}I by the sum-coincidence method was made. A gamma-spectrometric determination of ^{232}U was developed and applied. New half-life values for ^{76}As, ^{137}Cs, ^{140}La, and ^{232}U were measured. Trialkyl- and hexaalkylphosphorothioic triamides and metal di-n-butyl phosphorodithioates were studied as extractants for metals. Trivalent actinides were separated from lanthanides by liquid-liquid extraction with tricaprylmethylammonium thiocyanate. Tc was separated and determined by cyclohexanone extraction. Cellulose column chromatography was used to separate trace quantities of 13 metal ions from U. Separation of Te isomers in different chemical media was studied; work continued on the determination of Kr and Xe fission yields from U. Studies relative to ore selection for Project Coach were made. A search for a naturally occurring transuranic radionuclide was unsuccessful. Cooperative work in low-level analysis continued. Two new liquid scintillators, 1-methylnaphthalene and N,N′,N″-trimethylborazine, were studied. A liquid-scintillation method for absolute counting of beta emitters was developed. Several different computer techniques were applied to the resolution of gamma-ray spectra. A radio-release method was developed for the measurement of sulfur dioxide in the atmosphere. Radiotracers were used to study and to improve chemical procedures for Na, Li, and P. The problem of separation of Na from activated samples received continuing attention. A study of precision in activation analysis was begun. In applications of activation analysis to forensic problems, ammunition primer and gunshot residues, as well as hair and paper, were studied. Trace-element nutritional investigations in humans and animals were continued, and a number of unusual samples, both biological and chemical, were analyzed. Analyses for trace elements in uranyl nitrate solutions and in high-purity Be, Al, and Fe were made by neutron activation. In addition, isotopic neutron sources were used for the analysis of organo-boron compounds and high-cross-section materials in reactor fuel elements. A rapid method to calculate the output spectra from the 14-Mev neutron generator was formulated; a catalog of 14-Mev neutron reactions for elements of Z = 3 to 30 was prepared. Work on fast-neutron cross sections for Ti continued. An improved sample-irradiation and sample-handling system (primarily for O_2 determination) was designed. The neutron generator was used for the analysis of a number of materials and for the evaluation of neutron yields from experimental targets. Excitation functions and other nuclear data were gathered from experimental runs made at the 5.5-Mev Van de Graaff accelerator with ^3He particles; the potential usefulness of such procedures for activation analysis is being investigated. (J.R.D.)

17782 (ORO-592) A DISSOLVED OXYGEN ANALYZER. Final Report. Arthur S. Gillespie, Jr., and Harold G. Richter (Research Triangle Inst., Durham, N. C.). Dec. 31, 1963. Contract AT(40-1)-2513. (RTI-2513-T11). 36p. Dep.; $2.00(cy), 1(mn) CFSTI.

Based on the principle of radio release analysis, an instrument to determine dissolved oxygen in sea water, drinking water, and water samples from streams and ponds has been constructed. The dissolved oxygen in the sample reacts with ^{204}Tl metal in the instrument thereupon releasing a stoichiometric quantity of $Tl-^{204}Tl$ ion whose activity is measured in a liquid flow beta counter. The instrument is portable and battery operated for field operations. It is not significantly affected by most dissolved salts and some common oxidizing agents above pH 5. The response is linear (a direct function of oxygen concentration) and with a specific activity of 2 millicuries ^{204}Tl per gram of thallium, oxygen concentrations above 0.2 ppm are easily measured. Precision at the 1 ppm level is about ±5%, which can be improved by using higher specific activity ^{204}Tl. (auth)

17783 (RL-SEP-46) THE GAMMA ANALYTICAL SYSTEM AT REDOX. W. H. Zimmer (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 1964. Contract AT(45-1)-1350. 51p. Dep.; $3.00(cy), 1(mn) CFSTI.

The gamma analytical system at Redox uses linear equations to solve for activity components in a system of mixed isotopes. An IBM 7090 computer program has been installed to accomplish this; another program formulates the linear equation components from direct calibrations for use in the solutions. Counting geometries and analyzer response functions are held constant with the aid of a system of routine checks. Through the use of this system, it has been possible to provide accurate, nondestructive gamma energy analysis over a wider range of activities and in more complex mixtures than could be provided by any other known system. This versatility has been accomplished without affecting the accuracy of energy analysis of single isotopes and simple isotopic mixtures. (auth)

17784 (SGAE-CH-9/1964) AKTIVIERUNGSANALYTISCHER NACHWEIS VON SPURENELEMENTEN IN POLYÄTHYLENE. (Determination of Trace Elements in Polyethylene by Activation Analysis). H. Sorantin and P. Patek (Österreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf (Austria). Institut für Chemie). 1964. 33p. Dep.(mn).

The use of interference-free activation analysis for a survey of the type and amount of trace elements occurring in polyethylene was investigated. Seventeen elements could be detected qualitatively, and quantitatively determined by comparison with standards irradiated simultaneously. Variations in the trace contents in individual samples of the same lot could not be detected. A visual examination of polyethylene after neutron irradiation showed that in the low-pressure types trace elements could be detected after five minutes exposure, but a one hour exposure was necessary for the high pressure polymers. (tr-auth)

17785 (SGAE-CH-11/1964) ZERSTORUNGSFREIE BESTIMMUNG VON VERUNREINIGUNGEN IN REIN-NIOB DURCH NEUTRONENAKTIVIERUNG UND GAMMA-SPEKTROMETRIE. (Interference-Free Determination of Impurities in Pure Niobium by Neutron Activation and Gamma Spectrometry). J. Grosel and H. Sorantin (Österreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf (Austria)). 1964. 20p. Dep.(mn)

A neutron-activation method combined with γ spectrometry to determine the Ta, W, and Mn impurities in pure niobium was described. The method was fast and sensitive and could be used for both qualitative and quantitative analysis. (J.S.R.)

17786 (SZS-4) FLUORIMETRISCHE BESTIMMUNG DES URANS. (Fluorometric Determination of Uranium).

H. Scheel (Staatliche Zentrale fur Strahlenschutz, Berlin (East Germany)). Sept. 1964. 25p. Dep.(mn).

A review on fluorometric determination of uranium is given. Construction and characteristics of some instruments as well as preparation of fluxes are described. It is concluded that it is possible even with simple instruments to get good results. Some experiences with a reflection-type fluorometer are reported. (auth)

17787 (TID-7015(Indexes)(Rev.2)) INDEXES TO THE OAK RIDGE NATIONAL LABORATORY MASTER ANALYTICAL MANUAL, 1953–1964. Helen P. Raaen and Ann S. Klein, eds. (Oak Ridge National Lab., Tenn.). 166p. Dep.; $1.75(cy), 3(mn) CFSTI.

A keyword index, a bibliographic index, an author index, and a method-number index are given to all unclassified methods included in the Manual from 1953 through 1964. The bibliographic index gives the complete history and current status of each method. (D.L.C.)

17788 (TID-7015(Suppl.7)) OAK RIDGE NATIONAL LABORATORY MASTER ANALYTICAL MANUAL. (Oak Ridge National Lab., Tenn.). Jan. 13, 1965. Contract W-7405-eng-26. 504p. Dep.; 15.25(cy), 8(mn) CFSTI.

This supplement contains 94 new methods to be added to the Manual. The new methods fall into the following sections: ionic, radiochemical, mass spectrometric, spectrographic, and process methods. Nineteen revisions to previously issued ionic, radiochemical, and process methods are also given. (D.L.C.)

17789 (TID-7022(Vol.I)(Bk.1)) ANALYTICAL CHEMISTRY MANUAL OF THE FEED MATERIALS PRODUCTION CENTER. GENERAL INFORMATION; GENERAL ANALYTICAL METHODS: ACID CONCENTRATION THROUGH HYDROGEN (TOTAL) IN URANIUM METAL. (National Lead Co. of Ohio, Cincinnati). Dec. 1964. Contract AT(30-1)-1156. 308p. Dep.; $3.25(cy), 5(mn) CFSTI.

The organization of the Analytical Dept. of National Lead Company of Ohio and of the Wet Chemical Analytical Section is described. The safety aspects of equipment, chemicals, etc., are discussed. The equipment and practice of the Wet Chemical Analytical Section are described in some detail. A compilation is presented of the methods used for constituents beginning with A, B, C, D, F, and H. (D.L.C.)

17790 (TID-7022(Vol.II)) ANALYTICAL CHEMISTRY MANUAL OF THE FEED MATERIALS PRODUCTION CENTER. VOLUME II. INSTRUMENTAL ANALYTICAL SECTION. (National Lead Co. of Ohio, Cincinnati). Dec. 1964. Contract AT(30-1)-1156. 550p. Dep.; $5.50(cy), 8(mn) CFSTI.

The functions, standard practices, and equipment of the emission spectrochemical, x-ray spectrometric, mass spectrometer, and radiometric laboratories are described. Analytical procedures are compiled for each laboratory. (D.L.C.)

17791 (UR-658) A METHOD OF ANALYSIS OF AIR SAMPLING DATA FOR PARTICULATE ALPHA EMITTERS IN A RADON–THORON DAUGHTER ATMOSPHERE. Otto G. Raabe and Fred S. Patterson (Rochester Univ., N. Y. Atomic Energy Project). Aug. 28, 1964. Contract W-7401-eng-49. 92p. Dep.; $3.00(cy), 2(mn) CFSTI.

The analysis of air sampling data of particulate alpha emitters in a radon-daughter and thoron-daughter atmosphere is generalized to allow rapid and accurate calculations with a minimum of restrictions. A rigorous regression analysis is described giving statistical error confidence limits and the magnitude of inherent mathematical errors. The method described for this analysis does not require equilibrium conditions for the alpha emitters involved, averaging of the alpha counts over the period of counting, or limiting of the maximum number of alpha-count observations that may be made and used in the computations. Also described is a complete IBM FORTRAN program for performing the analysis and plotting the sample decay results using the CALCOMP Digital Plotter in conjunction with an IBM 7074 computer. (auth)

17792 (UCRL-Trans-1188(L)) APPLICATION OF GAMMA SPECTROMETRY TO THE STUDY OF THE RADIOACTIVE CONTAMINATION OF MILK. Ch. A. Bizollon and R. Moret. Translated by W. Robinson (Univ. of California, Livermore), from Lait, 44: 241-50(1964). 17p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

A method is described enabling identification and measurement to be made of traces of γ emitters dissolved in milk. The counting equipment comprises two probes, one fitted with an NaI(Tl) crystal, the other with a plastic scintillator. Use of these two detectors connected to a 128-channel γ spectrometer enables simple spectra containing only total absorption lines to be obtained, even from mixtures of radioactive elements. The container for receiving the milk samples is spherical and has two housings for the probes. It is placed in a compartment with shielding 5 cm thick. The measurement is carried out in 210 minutes for each detector, directly on the liquid sample, without the necessity of concentrating it by evaporation or of extracting the radioactive elements from it by appropriate reagents. It is then sufficient to read the resulting γ spectra and interpret them. This method has the advantage of being simple, rapid, and of lending itself to serial measurements. On the other hand, it does not allow measurement of the activity of pure β emitters, in particular $^{90}Sr-^{90}Y$, which is investigated by a technique especially suited to that element. (auth)

17793 (UCRL-Trans-1189(L)) A METHOD FOR DETERMINING FLUORINE IN FOODSTUFFS AND IN ORGANS AND TISSUES OF ANIMALS. S. K. Gushchin. Translated by Adam M. Mincer (Univ. of California, Lawrence Radiation Lab., Livermore), from Vopr. Pitaniya, 19: No. 6, 71-4(1960). 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.10(fs), $0.80(mf) JCL.

A method is described for the determination of fluorine in foodstuffs and animal organs and tissues. The method allows determination to within 1γ of fluorine in 30 to 45 minutes time. Generally accessible reagents are used, which may be stored over a long period. (auth)

17794 GAMMA-RAY SPECTROMETRIC ANALYSIS OF THE CONCENTRATIONS OF Cr, Ag, Fe, Co, Rb, AND Pt IN NORMAL HUMAN ENAMEL. R. Soeremark and M. Lundberg (Univ. of Umea, Sweden). Acta Odontol. Scand., 22: 255-9(1964).

The concentrations, on the basis of dry weight, of Rb, Cr, Ag, Fe, Co, and Pt in normal human enamel were studied. The values were obtained from fifteen intact first bicuspids from 14- to 16-year-old boys and girls. The concentrations were studied by means of thermal neutron activation analysis of the individual enamel samples. (Excerpta Med., Sect. XXIII, 2: No. 2(Feb. 1965))

17795 COMPUTATIONAL AIDS FOR IDENTIFYING CRYSTALLINE PHASES BY POWDER DIFFRACTION. Ludo K. Frevel (Dow Chemical Co., Midland, Mich.). Anal. Chem., 37: 471-82(Apr. 1965).

A comprehensive computer program was devised to carry out the entire searching-and-matching process of phase identification by powder diffraction. The input information consists of the powder data and elemental data of a sample. The output of the program is in the form of a report listing the experimental diffraction data in juxtaposition to the 10 most intense lines for each matched standard. (auth)

17796 SIMULTANEOUS USE OF BETA-PARTICLE TRANSMISSION AND BACKSCATTER GAUGES FOR DETERMINING HYDROGEN, CARBON, AND OXYGEN PERCENTAGES IN LIQUIDS. R. P. Gardner and J. W. Dunn, III (Research Triangle Inst., Durham, N. C.). Anal. Chem., 37: 528-30(Apr. 1965).

The simultaneous use of beta transmission and backscatter gages is discussed and demonstrated for the analysis of hydrogen, carbon, and oxygen in liquids containing only these three elements. The standard deviations for analyzing for these three elements with the gages used in this study for 10 liquid samples were 0.64, 2.2, and 1.7% for hydrogen, carbon, and oxygen, respectively. With im-

provements such as temperature control for the transmission gage samples and a thin cover for the backscatter gage sample, the standard deviation of the measurement could be reduced to less than 0.1% for hydrogen and 0.5% for carbon and oxygen. (auth)

17797 TRACE OXYGEN DETERMINATION IN CESIUM METAL AND THE PROBLEM OF RECOILS FROM THE ATMOSPHERE DURING FAST-NEUTRON ACTIVATIONS. Oswald U. Anders and David W. Briden (Dow Chemical Co., Midland, Mich.). Anal. Chem., 37: 530-3(Apr. 1965).

A method to determine oxygen traces of 5 to 500 ppm in highly reactive materials (cesium metal) by fast neutron activation analysis was developed. The preparation of the low-cost, low-oxygen-content polyethylene vials used is described. The effect of recoiling nuclei from the activation of the atmosphere surrounding the sample vial was studied and found to be proportional to the surface area in contact with air during the irradiation. (auth)

17798 TRACE IMPURITY ANALYSIS OF THORIUM–URANIUM AND PLUTONIUM–THORIUM–URANIUM ALLOYS BY ANION EXCHANGE–PARTITION CHROMATOGRAPHY. Edmund A. Huff (Argonne National Lab., Ill.). Anal. Chem., 37: 533-6(Apr. 1965).

An analytical method was developed for the determination of trace impurities in high-purity thorium–uranium and plutonium–thorium–uranium alloys. The procedure involved separation of metal contaminants from the alloy matrix by column elution in an 8N nitric acid medium. The two-phase chromatographic column incorporated a strong base anion exchange resin for the absorption of plutonium(IV) and thorium(IV), and a TBP-coated trifluorochloroethylene polymer for the retention of uranium(VI). A one-pass elution effectively removed the matrix constituents, while most impurities of interest remained in the effluent, and were determined spectrographically, using the copper spark method. High concentrational sensitivity was attained without the inherent standardization and toxicity problems associated with the carrier distillation technique. (auth)

17799 FLUOROMETRIC STUDY OF THE BERYLLIUM–MORIN SYSTEM. Mary H. Fletcher (Geological Survey, Washington, D. C.). Anal. Chem., 37: 550-7(Apr. 1965).

Three principal beryllium–morin complexes, a (1 + 1) monomer, a (1 + 1) dimer, and a (1 + 2) complex were found and conditional equilibrium constants for their formation were evaluated. Approximate ionization constants, absorption spectra, and the relative fluorescence intensities for five ionic species of morin were also determined in a spectrophotometric and fluorometric study of morin. The following interrelationships are discussed: pH, ionization of morin, absorption spectra of the various ionic species of morin and of the beryllium–morin complexes, equilibria for the reactions between beryllium and morin, the period of time between preparation of the solution and measurement of the fluorescence, and fluorescence intensity. (auth)

17800 GASOMETRIC DETERMINATION OF NITROGEN IN REFRACTORY METAL NITRIDES OF GROUPS IVB, VB, AND VIB. L. P. Morgenthaler and R. P. Menichelli (Western Electric Co., Inc., Princeton, N. J.). Anal. Chem., 37: 570-1(Apr. 1965).

The nitrides of the methods of groups IVB, VB, and VIB can be quantitatively reacted with an excess of dry chlorine gas below 600°C in a sealed reaction tube to form the corresponding metal chloride and nitrogen gas. Subsequent absorption of the excess chlorine by strong caustic solution and trapping of the residual nitrogen in a gas micro buret allows a quantitative estimation of the nitrogen to be made. The technique is theoretically applicable to the determination of nitrogen in other metals and alloys. (auth)

17801 RAPID DETERMINATION OF STRONTIUM-90 IN BONE ASH VIA SOLVENT EXTRACTION OF YTTRIUM-90. Henry G. Petrow (New York Univ., Tuxedo). Anal. Chem., 37: 584-6(Apr. 1965).

The use of di-(2-ethylhexyl) phosphoric acid (EHPA) for determination of ^{90}Sr in bone ash by solvent extraction of ^{90}Y. The bone ash is dissolved in HCl and ^{90}Y extracted with EHPA. The activity of ^{90}Y is counted and the ^{90}Sr content calculated. The chemical yield of yttrium from known samples was 96%. Decontamination factors were determined for various radioisotopes. (M.C.G.)

17802 CHEMICAL ANALYSIS OF THORIUM PHOSPHIDES. Daniel W. Wilson and Karl A. Gingerich (Pennsylvania State Univ., University Park). Anal. Chem., 37: 595-6(Apr. 1965).

The phase boundary compositions in thorium phosphides could be determined by changes in lattice parameters with composition. A method of determining composition was developed. The samples were dissolved in nitric acid with the addition of potassium permanganate to ensure complete oxidation of phosphorus to phosphate. Thorium was separated as the oxalate and determined by EDTA titration. Phosphate was precipitated with zirconium and determined gravimetrically. (M.C.G.)

17803 COLOR QUENCH CORRECTION IN LIQUID SCINTILLATOR SYSTEMS USING AN ISOLATED INTERNAL STANDARD. H. H. Ross (Oak Ridge National Lab., Tenn.). Anal. Chem., 37: 621-3(Apr. 1965). (ORNL-P-705)

A technique of color quench correction in liquid scintillators is described. The isolated standard technique is based on the absorption of light photons in a color-quenched liquid scintillator sample. The light source consisted of a small ampoule containing an unquenched liquid scintillator spiked with the desired isotope. The photons emitted by the standard had the same intensity and spectral distribution as those produced in the sample itself. Data indicated that the isolated internal standard is in very good agreement with the normal internal standard. (M.C.G.)

17804 A STUDY OF THE DETERMINATION OF TOTAL CARBON IN URANIUM CARBIDE BY VARIOUS METHODS. G. Serrini and J. Collin (EURATOM, CCR, Ispra, Italy). Anal. Chim. Acta, 32: 148-56(Feb. 1965). (In French)

A comparative study was made of the reproducibilities obtained for the determination of total carbon in uranium monocarbide by different analytical techniques: macro- and microgravimetry, electric conductivity, thermal conductivity, coulometry, gaseous volumetry, and manometry. (auth)

17805 THE DETERMINATION OF TRACE AMOUNTS OF ZIRCONIUM, HAFNIUM, THORIUM AND CERIUM IN SILICATE ROCKS. F. Culkin and J. P. Riley (Univ. of Liverpool). Anal. Chim. Acta, 32: 197-210(Mar. 1965).

A method is described for determination of traces of zirconium, hafnium, cerium, and thorium in rocks. After decomposition of the sample, these elements were separated from the major component elements by extraction from 10N nitric acid with a 40% solution of tri-n-butyl phosphate. Cerium was oxidized with bromate. After back-extraction the elements were separated from each other and from other extracted elements by cation exchange. Zirconium was determined photometrically with quinalizarin sulfonic acid, which gave about twice the sensitivity of alizarin red S. Thorium was determined photometrically with thorin, and cerium by utilizing its bleaching action on iron(II) phenanthroline. Hafnium was determined spectrographically. (auth)

17806 THE SUCCESSIVE COMPLEXIMETRIC DETERMINATION OF THORIUM AND URANIUM IN NITRATE SOLUTION. B. H. J. de Heer, Th. van der Plas, and M. E. A. Hermans (Euratom, R.C.N., K.E.M.A., Arnhem, Netherlands). Anal. Chim. Acta, 32: 292-3(Mar. 1965).

A complexiметric titration method was developed for determination of uranium and thorium in nitrate solutions at pH 3.5, with xylenol orange indicator, the solution was titrated with EDTA to change the color from red to yellow. A roughly 100% excess of EDTA with respect to uranium was added. Formaldehyde and sodium dithionite were added, and the color changed from brown to green. More

indicator solution was added, the pH adjusted to 3.5 to 4.0, and the solution titrated with standard thorium solution to change the color from yellow to red. (M.C.G.)

17807 DETECTION OF BORON BY AUTORADIOGRAPHY AFTER NEUTRON IRRADIATION. I. APPLICATION TO STEELS. J. Casanova and T. Carballas (Facultad de Ciencias, Santiago de Compostela, Spain). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 60: 119-26(May-June 1964). (In Spanish)

A technique for boron detection based on reaction $^{10}B(n,\alpha)^{7}Li$, using nuclear emulsion as detectors for particles, is proposed. The problem of interference of the reaction $^{14}N(n,p)^{13}C$ which takes place simultaneously was solved. The results obtained with several boron steels are shown. (auth)

17808 DETERMINATION OF ^{3}H IN SUBSTANCES CONTAINING A LARGE AMOUNT OF ^{131}I-ACTIVITY. B. L. Brown and W. S. Reith (Inst. of Nuclear Medicine, Middlesex Hospital Medical School, London). Biochim. Biophys. Acta, 97: 378-9(Feb. 15, 1965).

A method is described for the determination of ^{3}H contained in iodotyrosine derivatives. Data on the results of ^{3}H determinations obtained by combustion of n-(1,2-^{3}H)-hexadecane by itself, and with added ^{131}I-iodide are tabulated. (P.C.H.)

17809 THE SYNTHESIS OF 2-(1,8-DIHYDROXY-3,6-DISULFO-2-NAPHTHYLAZO)-PHENOXYACETIC ACID AS A NEW REAGENT AND ITS THORIUM COMPLEX. Kyoji Toei, Haruo Miyata, Toshiya Shibata, and Sadao Miyamura (Okayama Univ., Japan). Bull. Chem. Soc. Japan, 38: 334-5(Feb. 1965).

The preparation of 2-(1,8-dihydroxy-3,6-disulfo-2-naphthylazo)-phenoxyacetic acid and determination of its acid dissociation constant are described. Spectral properties of its thorium complex are discussed. (M.C.G.)

17810 APPLICATION OF RADIOACTIVATION ANALYSIS TO DETERMINATION OF MOLYBDENUM IN LEGUMES. J. Roderbourg, F. Massaux, and R. Kirchmann (C.A.M.I.R.A., Gembloux, Belg.). Bull. Inst. Agron. Sta. Rech. Gembloux, 31: 537-49(1963). (In French)

The principle of the activation technique for the determination of elements is reviewed. The method as applied to the analysis of legumes for Mo is discussed. The experimental study showed that this technique makes possible the determination of Mo with the precision of 15% for quantities of the order of the ppm with a sensitivity of 0.1 μg Mo. (J.S.R.)

17811 CONTRIBUTION TO THE STUDY OF MEASUREMENT OF WEAK BETA'S OF CARBON-14 BY LIQUID SCINTILLATORS. M. A. Picard, R. Kirchmann, J. Dulcino, and F. Massaux. Bull. Inst. Argon. Sta. Rech. Gembloux, 31: 550-62(1963). (In French)

The applicability of the measurement of low energy β radiation with liquid scintillators to vegetable physiology was studied. The measurement of ^{14}C in apple leaves using various scintillating compounds was examined. The effects of the gel, ethyl alcohol, and the chemical form of the labeled compounds were determined. It was concluded that two hypotheses are possible. The gel could have a favorable effect at the level of the energy transmission in the scintillator, or ^{14}C-sucrose could have a degrading effect on the scintillators and these could be protected by the gel. (J.S.R.)

17812 PHOTOMETRIC DETERMINATION OF ZIRCONIUM IN IRON AND STEEL, USING ARSENAZO III IN NITRIC ACID SOLUTION. Ohiko Kammori, Isamu Taguchi, and Ryohei Komiya (Yawata Iron and Steel Co., Ltd., Kawasaki, Kanagawa, Japan). Bunseki Kagaku, 14: 106-10 (Feb. 1965). (In Japanese)

A method for the photometric determination of 0.01 to 0.5% zirconium in iron and steel with Arsenazo III in nitric acid solution was studied. The absorbance in the nitric acid solution was more independent of the acid concentration than in the hydrochloric acid solution. One tenth gram sample was decomposed with nitric acid and hydrofluoric acid, heated, and evaporated with perchloric acid to white fumes. One tenth aliquot was taken and 50 ml of nitric acid and 5 ml of 10% urea solution were added. Ten ml of 0.1% Arsenazo III solution were added to form a blue complex and the solution was diluted with water to 100 ml. Zirconium was determined from the absorbance at 665 mμ. The determination was carried out in the presence of iron within an absolute error of 0.005%. The time required for the analysis was about 30 min. Elements commonly present in iron and steel scarcely interfered (auth)

17813 PHOTOMETRIC DETERMINATION OF URANIUM IN IRON AND STEEL WITH ARSENAZO III. Ohiko Kammori, Isamu Taguchi, and Kenzi Yoshikawa (Yawata Iron and Steel Co., Ltd., Kawasaki, Kanagawa, Japan). Bunseki Kagaku, 14: 111-15(Feb. 1965). (In Japanese)

A method for the photometric determination of 0.02 to 0.7% uranium in iron and steel with Arsenazo III was studied. Uranium was determined after it was reduced to the four valence stage by the liquid zinc amalgam reduction method. Two tenth gram sample was decomposed with hydrochloric acid and hydrogen peroxide. One tenth aliquot was taken and reduced in 6N hydrochloric acid for 2 min by the liquid zinc amalgam. Five ml of 0.1% Arsenazo III was added to form a blue complex, and the solution was diluted to 100 ml with 6N hydrochloric acid. Uranium was determined from the absorbance at 666mμ. The determination was carried out in the presence of iron within an absolute error of 0.01%. The time required for an analysis was about 40 min. Elements commonly present in iron and steel except zirconium scarcely interfered. (auth)

17814 A CENTRIFUGE TUBE FOR COLLECTING A RADIOACTIVE PRECIPITATE IN A COUNTING TRAY. D. M. Spracklen and A. M. Barnett (Kodak Ltd., Wealdstone, Eng.). Chem. Ind. (London), 50: 2061-2(Dec. 12, 1964).

Since transferring a radioactive solid from the centrifuge tube to a counting tray may be a difficult operation, a centrifuge tube, which allows the solid to be deposited directly in a planchette, was developed. The planchette can be removed from the tube and placed in a counting assembly with no further handling. The centrifuge tube was constructed of a stainless steel cylinder 0.75 × 5 in., and in two main parts, a barrel and a base, which holds a plunger. A stainless steel planchette is placed inside the base, which is then screwed to the barrel. The plunger is used to push the planchette out of the base after centrifuging. The top edge surface of the planchette and the bottom surface of the barrel are ground to provide a good fit. In use, a sample containing a radiotracer is placed in the tube and the top is screwed on. The whole tube is placed in a rubber adaptor inside a metal bucket for centrifuging. When centrifuging is complete an aliquot part of the supernatant may be placed in a planchette to dry, for subsequent counting. The base of the centrifuge tube is unscrewed, and the planchette containing the solid is removed with the help of the plunger. The count rates of both solid and supernatant may then be measured with a suitable counter. This tube was used with the weak β-emitting isotopes ^{14}C and ^{35}C. Sufficient solid is centrifuged to make the layer virtually an infinitely thick radioactive source, and an evenly deposited layer of solid is not necessary. However, experiments with much lower quantities of solid showed that the deposition is reasonably uniform over the area of the planchette, so that more energetic β-emitting isotopes could be used satisfactorily. (BBB)

17815 NONDESTRUCTIVE DETERMINATION OF PHOSPHORUS IN VARIOUS TYPES OF ANIMAL TISSUES BY MEANS OF THE NEUTRON ACTIVATION ANALYSIS. M. Rakovic and H. Talpova (Charles Univ., Prague). Chem. Zvesti, 18: 669-75(1964).

A nondestructive method for the determination of phosphorus in animal tissues is based on a twenty-hour long activation produced by a flux of neutrons of 1.5 by 10^{12} by cm^{-2} by s^{-1}, and on the direct measurement of the pulse frequency by the Geiger-Mueller counter, following a 14-day period of decay. Samples may weigh no more than 0.03 milligram. (OTS)

17816 DETERMINATION OF EXCHANGE IONS IN CLAY BY THE ISOTOPE-EXCHANGE METHOD. F. Macasek and A. Valent (Comenius Univ., Bratislava). Chem. Zvesti, 18: 698-701(1964).

The isotope exchange method was applied to the determination of exchange calcium in bentonites from Fintice. By means of a radioisotope with a high original specific activity it was possible to determine exchange ions in the polyionic forms of clay with practically no interference with the claywater system. (OTS)

17817 DETERMINATION OF SODIUM IN BIOLOGICAL FLUIDS BY MEANS OF THE NEUTRON ACTIVATION ANALYSIS. M. Rakovic and H. Talpova (Charles Univ., Prague). Chem. Zvesti, 18: 750-5(1964).

A destructive method is described for determining sodium in biological fluids. Samples are sealed in polyethylene covering. After activation their activity, including the covering, is measured by a scintillation probe using copper filters. A method for the mathematical evaluation of the covering activity effect including the background. (OTS)

17818 LIQUID SCINTILLATION COUNTING OF ^{35}S LABELED HYDROGEN SULPHIDE. D. S. Mahadevappa and R. L. Eager (Indian Inst. of Science, Bangalore). Current Sci. (India), 34: 15-16(Jan. 5, 1965).

A liquid scintillation technique was developed to determine the amount of ^{35}S-labeled H_2S produced in radiolysis of labeled alkali metal thiosulfates. The scintillator was a solution of 5.3334g 2.5-diphenyloxazole and 0.1333g 1.4-bis-2-[(5-phenyloxazolyl)]benzene in a liter of redistilled toluene. A known weight of the gamma-irradiated salt was dissolved in deaerated distilled water in an atmosphere of nitrogen. Pure, dry nitrogen was bubbled into the solution. The H_2S carried in the nitrogen stream was dried over calcium chloride and absorbed in 2 ml of hyamine hydroxide. The hyamine solution was then transferred to a counting bottle. The activities of both this solution and a standard solution containing labeled thiosulfate were determined on the scintillation counter. Comparisons of data from the scintillation method and the spectraphotometric method are presented. H_2S yields by the spectrophotometric method were slightly higher. (M.C.G.)

17819 THE NEUTRON-ACTIVATION OXYGEN METER USED IN INDUSTRIES AND ITS APPLICATIONS. Isao Fujii (Tokyo Shibaura Electric Co., Ltd.). Erekutoronikusu, 9: 437-44(Apr. 1964). (In Japanese)

A new neutron-activation oxygen meter for industrial use was developed. The apparatus consists of a Cockcroft-Walton type accelerator as the source of neutrons (T-D reaction, 14 Mev), an automatic sample exchanger using a pneumatic system, a neutron monitoring device to correct electrically the variation of neutron fluxes at the time of sample bombardment, and a scintillation (NaI) counter with a discriminator for the elimination of the background radiation. The statistical variation due to the counting can be determined by a 30-sec counting of the sample. For the determination of 1 mg of oxygen in a metal sample 12.0 mm in dia × 35.0 mm in length the variation is about 15%. With this oxygen meter, the oxygen content for Be, Si, W, Al, and Mg can be determined directly in a few minutes per sample regardless of its chemical state. Examples of the determination of oxygen in coals, chemicals, metals, oxides, and polypropylenes are given. (Nucl. Sci. Abstr. Japan, 3: (Nov. 1964))

17820 CARRIER DETERMINATION IN RADIOSTRONTIUM ANALYSES USING STRONTIUM-85. D. H. Keefer, L. F. Edmondson, and R. E. Isaacks (Public Health Service, Washington, D. C.). Health Phys., 11: 193-7(Mar. 1965).

A radiometric method was developed for determining strontium recovery in strontium-89 and strontium-90 analyses. This method makes possible the effective determination of strontium-85 in the presence of strontium-89 and -90 and vice versa. The strontium-85 activity per sample varies directly with the beta activity for maximum counting efficiency. The use of a radiocarrier eliminates the need for flame photometric determinations of strontium. (auth)

17821 RADIONUCLIDE FRACTIONATION IN FALLOUT PARTICLES. Tetsuo Mamuro, Kazuko Yoshikawa, and Nobufumi Maki (Radiation Center of Osaka Prefecture). Health Phys., 11: 199-209(Mar. 1965).

The radionuclide fractionation seen in the highly radioactive primary fallout particles that were produced in Russian air-bursts carried out in the autumns of 1961 and 1962 was investigated for γ-emitting nuclides by γ spectrometry and for ^{90}Sr and ^{89}Sr by conventional radiochemical analysis. It was revealed that the radiochemical composition of these particles is much enriched in $^{95}Zr + {}^{95}Nb$ and impoverished in ^{137}Cs, ^{89}Sr, ^{103}Ru, and ^{106}Ru, while the other nuclides take a middle position, and that there is a rough trend that a particle of larger size, namely of higher activity, was more affected by the fractionation effect. The fractionation factor defined previously was calculated in order to express the degree of fractionation in a particle for simplicity. The fractionation between ^{141}Ce and ^{144}Ce was not detected, but the fractionation between ^{90}Sr and ^{89}Sr was revealed to be considerable. There is a general trend that a particle of larger fractionation factor for a given nuclide has larger fractionation factors also for other nuclides. $^{237}U/^{95}Zr + {}^{95}Nb$ and $^{239}Np/^{95}Zr + {}^{95}Nb$ composition ratios of a highly radioactive particle are smaller than those of a mean fallout sample, respectively, and seem to decrease as its fractionation factor for $^{141}Ce + {}^{144}Ce$ decreases, although there are some exceptions. It is tentatively proposed that the order of increasingly larger fractionation factor for a nuclide in the fallout particles dealt with is as follows: [^{137}Cs, ^{89}Sr, ^{103}Ru, ^{106}Ru,] $^{140}Ba + {}^{140}La$, $^{141}Ce + {}^{144}Ce$, ^{90}Sr, ^{99}Mo, $^{95}Zr + {}^{95}Nb$, where the order of the four nuclides in the brackets was not determined with confidence. A relation seems to exist between particle color and fractionation factor. (auth)

17822 COMPLEXONOMETRIC DETERMINATION OF LANTHANOIDS AND CATIONS OF SOME METAL COMPOUNDS. Yu. V. Morachevskii and L. A. Vol'f (Leningrad State Univ.). Izv. Vysshikh Uchebn., Zavedenii, Khim. i Khim. Tekhnol., 7: 513-15(1964). (In Russian)

A complexonometric method using unithiol (sodium 2,3-dimercaptopropane sulfonate) as masking reagent, was developed for determining lanthanides (La and Ho) in the presence of Cd, Zn, Hg, Pb, Sn, Ga, In, Bi, and hydrogen sulfide in binary mixture. (R.V.J.)

17823 DETERMINATION OF THORIUM AND ITS SEPARATION FROM RARE EARTHS IN MONAZITE SAND. Tiao-Hsu Chang (National Taiwan Univ., Taipai). J. Chinese Chem. Soc. (Taiwan), 7: 33-40(May 1960).

Since it is time-consuming to separate thorium and rare earths from their accompanying constituents in monazite sand containing phosphate radicals, a faster means for the removal of phosphate radicals from the residue of monazite sand was devised based on digestion with sulfuric acid. The method described consists of four steps: decomposition of monazite sand with sulfuric acid; removal of phosphate radical by washing with alcohol; precipitation of Th, rare earths, and some other constituents in monazite sand with ammonium carbonate in the presence of tartaric acid; and separation of Th from the rare earths by the hydrolysis of urea in the presence of formic acid. The separation of Th, from a small amount of other constituents associated with the basic Th formate, was easily carried out by the oxalic acid method at the last operation. About 95% of phosphate radicals could be removed with alcohol. The formation of dense, easily filtered and washed precipitates resulted in a more accurate and rapid method. (BBB)

17824 THE USE OF ACTIVATION ANALYSIS IN PROCEDURES FOR THE REMOVAL AND CHARACTERIZATION OF THE SURFACE CONTAMINANTS OF HAIR. L. C. Bate (Oak Ridge National Lab., Tenn.). J. Forensic Sci., 10: 60-72(Jan. 1965).

Neutron activation analysis was investigated as a tool for identification of individuals through analysis of their hair. A method to properly clean hair from surface contamination was developed using activation analysis to evaluate various methods. Before washing, the trace elements most

frequently found in the hair samples were Br, Na, Cl, Mn, Au, Zn, Hg, and Al. Cr, Co, Se, Sb, and As were found in some samples. With the exception of sodium and bromine, these same elements were present in detergent-washed hair. Relative concentrations of each element are shown in tables. The radionuclides identified in all the organic washes were very similar. A fraction of the sodium and bromine, as well as various small amounts of manganese and chlorine, were removed from hair by organic washes. Hair washed with ionic detergent contained some sodium radioactivity, while samples washed in nonionic detergents were essentially free of sodium. It was concluded that the use of hair in individual identification will require the detergent-washing of hair after irradiation to remove surface contamination. (M.C.G.)

17825 DETERMINATION OF EPITAXIAL-LAYER IMPURITY DISTRIBUTION BY NEUTRON ACTIVATION METHOD. Toshio Abe, Kanro Sato, and Noboru Oi (Tokyo Shibaura Electric Co., Ltd.). Japan. J. Appl. Phys., 4: 70-1(Jan. 1965).

The determination of concentration profiles of As for outdiffused substrates and a Si epitaxial film by neutron activation is reported. The substrates were cut from As-doped ⟨111⟩ pulled ingot. An epitaxial wafer was prepared by hydrogen reduction of undoped $SiCl_4$. Decay curves were analyzed for ^{76}As and ^{31}Si components and the amounts of As and Si in each fraction were calculated by comparing the activities of respective standards. The detection limit of As was about 10^{11} atoms. (M.C.G.)

17826 DETERMINATION OF OXYGEN IN METALLIC MATERIALS BY THE RADIO-ACTIVATION ANALYSIS. Kiichi Narita and Masayuki Taniguchi (Kobe Steel Works, Ltd., Japan). Kobe Steel Works Eng. Rept., 14: 189-95 (July 1964). (In Japanese)

The radioactivation analysis for oxygen in metallic materials is described. When oxygen is bombarded with fast neutrons available from small accelerators employing the $_1H^3 + {}_1D^2 \rightarrow {}_2He^4 + {}_0n^1$ reaction for their production, nitrogen $_7N^{16}$ is formed by an (n,p) reaction. The $_7N^{16}$ decays to $_8O^{16}$ accompanied by β and γ rays. Consequently, the determination of oxygen is possible by measuring the intensity of the γ rays of $_7N^{16}$. Oxygen was determined in various metallic materials by using a new highly automated apparatus "ACTIVAC" for neutron activation analysis, which was developed in Tokyo Shibaura Electric Co., Ltd. It was concluded that the neutron activation technique lends itself to rapid determining of oxygen with high accuracy and good sensitivity in almost all ferrous and nonferrous materials. (auth)

17827 RAPID DETERMINATION OF THE ELECTROLYTICALLY-REDUCED U^{4+} CONTENT IN CONCENTRATED URANIUM SOLUTIONS. Jozsef Lovasi. Magy. Kem. Lapja, 19: 499-502(Sept. 1964). (In Hungarian)

A rapid method, accurate to within ±5%, was developed for determination of electrolytically reduced tetravalent uranium in concentrated solutions containing hexavalent uranium, trivalent iron, bivalent iron, bivalent manganese, chloride, and sulfate ions. The tetravalent uranium ions were converted into a phosphoric acid complex and the color of the complex solution was measured photometrically with the aid of 625-mμ light. One determination could be completed in approximately two minutes. The method was found to be suitable for process control purposes in the manufacture of tetravalent uranium fluorides by electrolytic reduction. (OTS)

17828 PURIFICATION AND STUDY OF THE PRINCIPAL PRODUCTS CONTAINED IN PREPARATIONS OF RADIOINSULIN. Thomas J. Merimee and Thaddeus E. Prout (Johns Hopkins Univ., Baltimore). Metab. Clin. Exptl., 14: 115-21(Feb. 1965).

A method for the separation and recovery of the two principal fractions of radioactive protein contained in radioinsulin preparations is described, and characteristics of degraded insulin-^{131}I were examined. Radioactive contaminants of ^{131}I-labeled insulin preparations were removed by a procedure based on the difference in affinity of cellulose for the pure insulin-^{131}I and the radioiodinated peptides. These contaminants were recovered and studied with respect to their electrophoretic migration and antigenicity. The degraded insulin was separated into two distinct fractions on agar or paper electrophoresis. One of these fractions moved toward the anode in buffer and in normal serum but with the γ-globulin in insulin immune serum. The difference between normal serum and serum containing insulin antibodies is explained by the fraction of degraded iodoinsulin remaining antigenically similar to undamaged insulin. The other fraction moved toward the cathode in buffer but toward the anode in normal or immune sera, this shift being prevented by the addition of iodoacetamide. The action of iodoacetamide may indicate that splitting of the iodoinsulin disulfide bonds is necessary before the change in electrophoretic migrations occurs. It is emphasized that in the use of insulin-^{131}I for immunoassay a highly purified and immunologically active preparation of insulin-^{131}I is necessary for the greatest accuracy of the procedure. Attempts to use Sephadex G-50 to isolate undegraded insulin-^{131}I were not successful. (BBB)

17829 CHLORINE-38 AND SULPHUR-38 PRODUCED BY COSMIC RADIATION. R. W. Perkins, C. W. Thomas, M. W. Hill, and J. M. Nielsen (General Electric Co., Richland, Wash.). Nature, 205: 790-1(Feb. 20, 1965). (HW-SA-3681)

The determination of ^{38}Cl and ^{38}S in rain water is described. Estimates of the expected production rates of the possible spallation products of argon showed that ^{38}Cl (half life, 37.3 min) should be present in the atmosphere at concentrations comparable with ^{39}Cl. The calculations also indicated that ^{38}S (half life 2.9 hr) should be present at a concentration of about an order of magnitude lower. The decay schemes of the radioisotopes permit direct measurement of their concentrations by coincidence counting techniques. It is speculated that the ratio of these cosmic-ray produced radioisotopes in rain water, which have half lives of the order of that required for a rain cloud to form, should provide valuable information about both cloud formation and the washing of the atmosphere by rain. (P.C.H.)

17830 POLONIUM IN CIGARETTES—SPECTROSCOPIC ANALYSIS. Avivi I. Yavin, Giovanni de Pasquali, and Paul Baron (Univ. of Illinois, Urbana). Nature, 205: 899-900(Feb. 27, 1965).

An investigation was made to: identify spectroscopically and measure the amount of ^{210}Po as well as other Po isotopes in cigarettes; and to present a fast and reliable detection system capable of determining accurately minute quantities of ^{210}Po (of the order of 10^{-2} $\mu\mu$C) as well as of mixtures of α-active isotopes. Two samples, each containing Po from two cigarettes, were measured. The two samples were prepared from cigarettes of the same brand but from different cartons and were both found to contain 0.45 ± 0.10 $\mu\mu$C per cigarette. The quoted uncertainty was mainly due to the uncertainty in solid angle and in plating efficiency. Background was 0.1 to 0.2 counts/hr and was less than 1% of the sample activity. A preliminary measurement was also made on the Po collected on a glass-wool filter when whole cigarettes were smoked in a stream of oxygen inside a heated flask. The results indicate that most of the Po follows the smoke. (P.C.H.)

17831 REACTOR PULSING IN ACTIVATION ANALYSIS. H. R. Lukens, Jr., H. P. Yule, and V. P. Guinn (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Instr. Methods, 33: 273-6(Mar. 1965). (GA-5702)

For neutron activation analysis with very short-lived activities ($t_{\frac{1}{2}} < 50$ sec) improved limits of detection are obtained by irradiating with TRIGA reactor neutron pulses rather than with steady-state irradiations. These pulses give peak fluxes of about 4.5×10^{16} n/cm^2 · sec compared to 10^{13} n/cm^2 · sec at maximum steady-state operation. Pulse width at half maximum is 15 msec. Therefore, short-lived radioactivities generated by pulses are not limited by the saturation factor and the pulse produces 50 times as much one-second half-life activity as can be generated by

irradiation to saturation activity at maximum steady-state flux. Sensitivity data are presented on a number of reactor fast- and thermal-neutron produced activities, and the results are compared with theoretical predictions. (auth)

17832 UTILIZATION OF REACTOR FAST NEUTRONS FOR ACTIVATION ANALYSIS. H. P. Yule, H. R. Lukens, Jr., and V. P. Guinn (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Instr. Methods, 33: 277-82(Mar. 1965). (GA-5691)

The intense fast-neutron fluxes typically available in reactor cores have been largely ignored for use in neutron activation analysis. In a number of situations, thermal neutron activation analysis gives insufficient sensitivity or ambiguous results due to matrix interference. The use of reactor fast neutrons to overcome these difficulties was studied for 35 elements. The reduction of interferences from thermal, epithermal, and resonance neutrons resulted in increased utility for analysis with reactor fast neutrons. Of the 35 elements studied, 6 have superior detection limits (sensitivities) for analysis with reactor fast neutrons compared to reactor thermal-neutron activation analysis. Fifteen elements have comparable sensitivities for fast and thermal neutrons, seven have poor sensitivities for fast neutrons and the remaining seven had negligible fast neutron product yields. (auth)

17833 ANALYSIS OF TRACE ELEMENTS IN ALUMINIUM BY NEUTRON ACTIVATION— DETERMINATION OF URANIUM IN ALUMINIUM. Masatoshi Kobayashi, Sumiko Nagatsuka, and Kunihiko Higashi (Tokyo Metropolitan Isotope Research Centre). Radioisotopes (Tokyo), 14: 8-12 (Jan. 1965).

A method for the determination of uranium in aluminum by activation is described. ^{239}Np, which is produced by the thermal neutron activation of ^{238}U (neutron flux 1.7×10^{12} $n/cm^2 \cdot sec$), was extracted selectively by TTA benzene solution under a suitable acid condition. By measuring the activity of ^{239}Np, 0.1 to 0.2 ppm of U can be determined in high purity Al. The method is comparatively rapid and simple and allows the determination of all small amount of U as 0.03 ppm in Al. (P.C.H.)

17834 DECONTAMINATION OF $^{90}Sr-^{90}Y$ FROM THE VARIOUS TYPES OF FABRICS. Yoshiki Wadachi, Yukio Kawano, and Yuzo Tajima (Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 14: 18-23(Jan. 1965). (In Japanese)

In order to survey a suitable protective cloth, which is used in the hot laboratory, 11 kinds of fabrics, such as the decontamination of hemp, hemp-cotton, cotton, hemp-vinylon, etc., were tested for $^{90}Sr-^{90}Y$. Each sample of fabric consisted of three types, namely untreated cloth, silicagel sizing cloth, and silicon water protected cloth. Results obtained show that hemp and cotton are good material for the protective cloth and cotton in particular is the most excellent one among them in respect to practice and economy. (auth)

17835 GAMMA SPECTROMETRY AND ANALYSIS BY ACTIVATION APPLICATION TO DETERMINATION OF IMPURITIES IN NATURAL FLUORITES. PART 2. C. Brooke and E. Peeters (Universite Libre, Brussels). Rev. M.B.L.E., 7: 266-89(Dec. 1964). (In French)

Principles of activation analysis are discussed, and a description of its use in determining impurities in natural fluorines given. All measurements were made by gamma spectrometry with different spectral interpretation techniques being applied. Activities of short and medium periods were examined by the decay of spectral lines and long periods by energy determination, spectrum subtraction, and coincidences. (auth)

17836 MICRO-ANALYSIS OF LITHIUM BY ISOTOPE DILUTION METHOD. II. DETERMINATION OF LITHIUM CONTENT IN SOME ALKALI REAGENTS. Setsuo Taniguchi (Osaka Univ.) and Hitoshi Tsuyama. Shitsuryo Bunseki, 12: No. 25, 21-4(May 1964).

The determination of lithium in potassium sulfate, sodium carbonate, and sodium hydroxide by an isotope dilution method was studied. The results obtained are $(1.01 \pm 0.17) \times 10^{-8}$ g/g of lithium in the potassium sulfate sample, 9.78×10^{-8} g/g of lithium in the sodium carbonate sample, and 2.19×10^{-7} g/g of lithium in the sodium hydroxide sample. The lithium content in a barium chloride sample was measured to be 1.36×10^{-8} g/g. (auth)

17837 SOIL WATER MEASUREMENT WITH GAMMA ATTENUATION. R. J. Reginato and C. H. M. van Bavel (Water Conservation Lab., Tempe, Ariz.). Soil Sci. Soc. Am., Proc., 28: 721-4(Nov.-Dec. 1964).

Gamma attenuation measurements of wet density were made with a 5-mC ^{137}Cs source over a pathlength of about 30 cm. Data were obtained for glass-and-water systems as well as for soil materials of varying water content. The equipment was designed for use in the measurement of water content of soil in situ in 1-cm. increments, without any collimation of the beam. Experimental results verify theoretical considerations on the use of gamma attenuation for soil water measurement. For equipment calibration, the unattenuated beam intensity and the attenuation coefficients for oven-dry soil and water need be determined to make use of the exponential inverse square law for calculating the water content, given the dry density. The data demonstrate that the difference in the attenuation coefficients of dry soil and water must be taken into account. Accuracy of the method, for a total count of 20,000, is 0.010 g cm^{-3} for water contents from 0.050 to 0.400 g cm^{-3} at a dry density of 1.300 g cm^{-3}. For the same total count, a precision of 0.006 g cm^{-3} is demonstrated. (auth)

17838 MEASUREMENT OF SEDIMENT DENSITY BY ATTENUATION OF TRANSMITTED GAMMA RAYS. J. Roger McHenry and Farris E. Dendy (USDA Sedimentation Lab., Oxford, Miss.). Soil Sci. Soc. Am., Proc., 28: 817-22(Nov.-Dec. 1964).

The measurement of density by observing the attenuation of transmitted gamma rays was adapted to the measurement of sediment density. A dual probe, utilizing transmission techniques, was evaluated for use in measuring the density of sediments collected from runoff of plots or small watersheds. The equipment consists of a 7-mC ^{137}Cs source placed in one access tube and a probe containing a NaI scintillation crystal, photomultiplier tube, and preamplifier in the second tube. The high-voltage power supply and scaler ratemeter for readout are supplied in a portable unit powered by silver-cadmium rechargeable dry cells. $^{137}Cesium$ gamma radiation is measured by employing electronic discrimination to eliminate all photons of energies below about 0.65 Mev. Sediment densities were measured in silt boxes installed on a small watershed at the North Mississippi Branch Experiment Station, Holly Springs, Mississippi, following laboratory calibration tests. The dual probe employed measured densities of sediments to within 0.01 absolute density units. The vertical resolution of the apparatus is less than 1 inch so that density measurements of thin layers and of materials at interfaces can be made. In one field test sediment weights, of the order of 8,500 pounds, computed for a silt box on the basis of dual probe density determinations varied less than 1% from a gravimetric determination. Changes in sediment density with time, with additional increments of sediment, and with storms were effectively measured. (auth)

17839 THE ISOTOPIC ANALYSIS OF ARGON WITH A PHILIPS OMEGATRON. Daniel Krummenacher (Laboratoire de Mineralogie, 22 Quai de l'Ecole de Medecine, Geneva). Vacuum, 14: 461-75(Dec. 1964).

Characteristics of an omegatron as used with a magnetic field of 9,000 gauss for isotopic analysis of argon are described. This analysis was quantitative, provided the sum of the positive ionic currents of the argon isotopes did not exceed 2×10^{-12} amp with an emission current of 1 μa. (auth)

17840 SPECTROPHOTOMETRIC STUDY OF THE REACTIONS OF YTTRIUM, LANTHANUM AND CERIUM WITH METHYL THYMOL BLUE. L. S. Serdyuk and V. S. Smirnaya (Dnepropetrovsk State Univ., Ukrainian SSR). Zh. Analit. Khim., 20: 161-4(1965). (In Russian)

It was established that yttrium, lanthanum, and cerium form complexes with methylthymol blue with maximum absorption at 600 mμ. It was found by the method of isomolar series that the metal—dye ratio in these complexes is 1 : 1 and that their unstability constants are correspondingly equal to $(1.2 \pm 0.1) \times 10^{-7}$, $(8.1 \pm 0.9) \times 10^{-7}$, and $(7.0 \pm 0.4) \times 10^{-7}$. The greatest difference between the optical densities of solutions of the reagent and complexes was observed at pH of 6.5. The possibility of photometric determination of yttrium, lanthanum, and cerium with methylthymol blue at pH of 6.5 was established. (auth)

17841 REDUCTION OF NIOBIUM (V) AND ITS DETERMINATION BY TITRIMETRIC AND PHOTOMETRIC METHODS. Yu. I. Bykovskaya (Baikov Inst. of Metallurgy, Moscow). Zh. Analit. Khim., 20: 178-82(1965). (In Russian)

A study was made of the effect of acidity, reduction time, and the temperature of the reaction mixture on the reduction of niobium(V) to niobium(III). Titrimetric and photometric methods were developed for the determination of the total niobium content. (auth)

17842 COULOMETRIC TITRATION OF IRIDIUM(IV) WITH ELECTROGENERATED COPPER(I) IN THE PRESENCE OF RHODIUM(III). N. I. Stenina and P. K. Agasyan (Moscow State Univ.). Zh. Analit. Khim., 20: 196-9(1965). (In Russian)

A simple and rapid method was developed for coulometric determination of relatively small amounts of Ir(IV) in the presence of Rh(III) by means of electrogenerated Cu(I) from a $CuSO_4$ solution in a 4M hydrochloric acid medium with potentiometric indication of the end point. The sensitivity of the method was $\sim 10^{-5}$M (~2 μg/ml). Rhodium did not interfere at the weight ratio of Ir(IV) : Rh(III) ≥ 1 : 25. Any amount of Fe(III) in the titrated solution interfered with Ir(III) determination by this method. (auth)

17843 THE USE OF HIGH-FREQUENCY DISCHARGE FOR THE ISOTOPIC ANALYSIS OF NITROGEN. Yu. A. Zonov (State Inst. of Applied Chemistry, Leningrad). Zh. Analit. Khim., 20: 205-8(1965). (In Russian)

A method is suggested for obtaining nitrogen samples for isotopic analysis from nitrogen-containing compounds. A sample of the substance mixed with carbon and sulfur is placed in a quartz test tube with a ground joint. The test tube is connected to a vacuum set and evacuated to remove the air. Then the mixture is exposed to high-frequency currents. Nitrogen evolving as a result of the high-frequency discharge is purified from other decomposition products and analyzed on a mass spectrometer. Two methods for nitrogen purification are suggested. It was found that, within the accuracy of mass spectrometric determinations, the isotopic composition of nitrogen is similar to that in the substance analyzed. (auth)

17844 DETERMINATION OF NIOBIUM IN HIGH-ALLOY STEELS. V. M. Dorosh and N. A. Ivanova (Karaganda Metallurgical Plant, Kazakh, SSR). Zh. Analit. Khim., 20: 259-60(1965). (In Russian)

A rapid method for the analysis of high-alloy steels is suggested. Niobium, molybdenum, tungsten, and chromium are determined from a single sample. (auth)

17845 DETERMINATION OF BETA ACTIVITY IN WATER. F. B. Barker and B. P. Robinson (Geological Survey, Washington, D. C.). Geological Survey Water-Supply Paper 1696-A. 1963. 35p.

Methods were developed for measuring certain radioactive substances in water. Because many water samples contain small amounts of radioactivity, low-level counting techniques must be used. The usual assumption that counting data follow a Gaussian distribution is invalid under these conditions, and statistical analyses must be based on the Poisson distribution. The gross beta activity in water samples is determined from the residue left after evaporation of the sample to dryness. Evaporation is accomplished first in a teflon dish, then the residue is transferred with distilled water to a counting planchet and again is reduced to dryness. The radioactivity on the planchet is measured with an anticoincidence-shielded, low-background, beta counter and is compared with measurement of a $^{90}Sr-^{90}Y$ standard prepared and measured in the same manner. Control charts are used to assure consistent operation of the counting instrument. (auth)

17846 CHIP MOISTURE MEASUREMENT BY NUCLEAR TECHNIQUE. James H. Folsom (S. D. Warren Co., Westbrook, Me.). 15p. (CONF-641013-1)

From Alkaline Pumping Conference, Atlanta.

The development of a fast, accurate, moisture test for wood chips using a nuclear technique is described. Included are five different phases of the development as well as a description of the set-up and results to date. This instrument is being used on a routine basis to determine the moisture content of purchased wood chips. Fast neutron slowing down by hydrogen is used as the basis for the instrument. (M.C.G.)

17847 AUTOMATIC ABSORPTION ANALYZING SYSTEM. Glenn E. Smith and Paul C. Watson (to Baird-Atomic, Inc.). U. S. Patent 3,156,819. Nov. 10, 1964. Filed Aug. 29, 1961.

An automatic apparatus for quantitatively analyzing chemical compounds by a radiation absorption device coupled with electronic integrating equipment adapted to respond to the presence of and variation in the concentration of a predetermined substance is patented. The sensing means include an infrared analyzer. In the radiation analyzer portion of the instrument, resistance detecting elements form arms of a self-balancing bridge, and a servo-motor responsive to a voltage difference across the bridge is used to maintain a balance in the bridge and also simultaneously to change the frequency of a pair of electronic oscillators by increasing the frequency of one and decreasing the frequency of the other. Means are provided for mixing the frequencies and for counting the total number of cycles of the difference frequency for a predetermined period, the count corresponding to the total detected amount of the predetermined substance. Specifically, the instrument is designed for the simultaneous analysis of carbon and sulfur. (A.G.W.)

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Refer also to abstracts 18236, 18437, 18621, 18681, and 19344.

17848 (AERE-M-1534) VAPOUR PRESSURES AND HEATS OF EVAPORATION OF WATER FOR SEA-SALT SOLUTION. E. Glueckauf (Atomic Energy Research Establishment, Harwell (England)). Feb. 1965. 6p. Dep.; $0.90(BIS); 1s.9d. (HMSO).

Osmotic coefficients were calculated for sea water, and vapor pressure depressions and excess heats of evaporation were derived therefrom for the temperature range 125 to 200°C. (D.L.C.)

17849 (AFWL-TDR-64-44) TABLES OF IDEAL GAS THERMODYNAMIC FUNCTIONS FOR 73 ATOMS AND THEIR FIRST AND SECOND IONS TO 10,000°K. Joseph Hilsenrath, Carla G. Messina, and William H. Evans (National Bureau of Standards, Washington, D. C.). [1964]. Contract AF(29-601)60-4491. 452p. (AD-606-163). $7.55 (CFSTI).

Tables are presented of five thermodynamic properties for the electron, for 73 elements, H through La and Hf through Ac [with the exception of At and Fr] and, in most cases, for their first and second ions. The tables are given at 100° intervals starting at 100°K for the atoms and at 100 or 1000° for the ions and extending to 10,000°K. They were computed for the atoms and atomic ions considered as ideal monatomic gases by direct summation over the available energy levels. The summation over energy levels was made from the ground state up to the principal quantum number 5. Where the quantum number, n, for the ground state exceeds 5, summations were made only over levels having the same n as the ground state. The

sensitivity of the thermal functions to the inclusion of higher energy states in the partition function is discussed briefly, illustrated graphically for the specific heats, and tabulated for the Gibbs free energy function. (auth)

17850 (CEA-R-2583) CONTRIBUTION A L'ÉTUDE DES IMPURETÉS HYDROGÉNÉES ET OXYGÉNÉES DANS LE SODIUM LIQUIDE. (Contribution to the Study of Hydrogenated and Oxygenated Impurities in Liquid Sodium). Gerard Naud (Commissariat a l'Énergie Atomique, Saclay (France). Centre d'Etudes Nucléaires). 1964. 48p. Dep.(mn).

Thesis submitted to Université, Rennes, France.

This study is made up essentially of two parts. The first is devoted to the development of dosage methods for selectively determining the oxygenated and hydrogenated impurities present in sodium, that is the oxide, the hydride, and the hydroxide. The second makes use of these methods for a study of the $Na-H_2-O_2$ system, as well as of the related problem of the attack of pyrex glass by molten sodium. The conventional method for dosing oxygen by amalgamation was first adapted to the simultaneous measurement of the hydride. A method was developed for dosing the total hydrogen by measuring successively the concentrations of gas present in the hydride and hydroxide form. This method is based on the thermal decomposition of the hydride and the reaction between sodium and the hydroxide. The study of the $Na-H_2-O_2$ system consists first of all in the study of the reaction between hydrogen and sodium in the temperature range from 150 to 150°C and at a pressure of about 150 mm of mercury. The study of the thermal decomposition of the hydride in sodium was then studied. It was possible to make some qualitative observations concerning the reaction between sodium and sodium hydroxide. Finally, some complementary tests made it possible to define the nature of the phenomena occurring during the attack of pyrex glass by sodium.(auth)

17851 (CEA-R-2611) PROPRIÉTÉS THERMODYNAMIQUES DE L'HYDROXYDE DE BERYLLIUM. ÉTUDE DU SYSTEME $BeO-H_2O-Be(OH)_2$. (Thermodynamic Properties of Beryllium Hydroxide: Study of System $BeO-HEO-Be(OH)_2$). Alain Baur and Alfred Lecocq (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Nov. 1964. 26p. Dep.(mn).

The study of the hydro-thermal decomposition of beryllium hydroxide has made it possible to determine the free energy of formation and the entropy. The results obtained are in good agreement with the theoretical values calculated from the solubility product of this substance. They give furthermore the possibility of acquiring a better understanding of the $BeO-H_2O-Be(OH)_2$ system between 20 and 1500°C. (auth)

17852 (CEA-R-2633) CONTRIBUTION A L'ETUDE DE LA CONDUCTIVITE DE L'EAU DE HAUTE PURETE. (Contribution to the Study of the Conductivity of High-Purity Water). Chantal Nens (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Dec. 1964. 67p. Dep.(mn).

A study is made particularly of two points: the production of high-purity water and the estimation of this purity by means of conductivity measurements. As far as water purification is concerned, it is observed that the deionization produced by ion exchange resins in mixed beds leads to a water having a lower conductivity than that obtained by distillation. This low conductivity however, measured at the column exit before the water comes into contact with air is not stable. In fact, the carbon dioxide in the water gives rise to an equilibrium with production of the ions HCO_3^-, CO_3^{-2}. These ions are retained during the passage of the water through the resins. They reappear again at the column exit as a result of the displacement of the hydration equilibrium of CO_2; because of this, the conductivity of the water increases with time. The water obtained by successive distillations does not behave in the same way because no carbon dioxide is present. Distillation is however a costly purification process on an industrial scale, especially if large quantities of water have to be treated. The measurement of these low conductivities is very delicate. The method employed makes use of a direct current and gives reproducible results if care is taken to exclude interfering electric fields by screening the apparatus. (auth)

17853 (CEA-R-2705) PROPRIETES MAGNETIQUES DES IONS DE KRAMERS DE TERRES RARES DANS LES GRENATS DE TERRES RARES ET D'ALUMINIUM ET LES GRENATS DE TERRES RARES ET DE GALLIUM. (Magnetic Properties of Kramers Rare Earth Ions in Aluminum and Gallium Garnets). Hans W. Capel (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Dec. 1964. 93p. Dep.(mn).

The magnetic properties of Kramers rare earth ions in aluminum and gallium garnets (MAlG and MGaG) are discussed by means of a molecular field treatment. The symmetry properties of the space group permit one to establish a parametrization for the magnetic dipolar and exchange couplings. The magnetic properties of the system can be expressed in terms of these parameters and the g factors of the rare earth ions. The transition temperatures, sublattice magnetizations, susceptibility in the paramagnetic region, and antiferromagnetic susceptibility were calculated for a special type of magnetic ordering. The influence of the excited Kramers doublets is described by means of a generalization of the usual g tensor. (auth)

17854 (EURAEC-772) THE KINETICS OF RARE-GAS DIFFUSION IN SOLIDS. Tables and Graphs for the Evaluation of Post-Activation Diffusion Experiments. (Rare-Gas Diffusion in Solids 10). T. Lagerwall and K. E. Zimen (Hahn-Meitner-Institut für Kernforschung Berlin (West German)). 1964. Work Performed under United States–Euratom Joint Research and Development Program Contracts 064-61-8-RDD and 094-62-9-RDD. 36p. (EUR-1372.e) Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The exact solution of the equation for the kinetics of diffusion of rare-gas atoms out of a crystal, where they have been created by irradiation and nuclear reaction, has been calculated with a digital computer in spherical, cylindrical, and rectangular symmetries for different crystal parameters. The results are presented in graphs and tables which permit a general and direct evaluation of post-activation-diffusion (PAD) experiments made with crystals of spherical form, and of any cylindrical or rectangular form. (auth)

17855 (HW-SA-3439) REACTION OF TSX GRAPHITE WITH WATER VAPOR. R. C. Giberson and J. P. Walker (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 1964. Contract AT(45-1)-1350. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The rate of reaction of TSX graphite with water vapor in a helium stream is given by: $R = 4.78 \times 10^9\ e^{-70,200/RT}\ p^{\frac{1}{2}}(g/g/hr)$ in the temperature range from 750 to 900°C and in the range of water-vapor partial pressure p of 0.10 to 25.0 mm. This result is obtained in the absence of hydrogen. A mechanism involving dissociation of the water molecule on two active sites is proposed to account for the square-root pressure dependence. (auth)

17856 (MIT-2249-1) RATE OF EXCHANGE OF DEUTERIUM BETWEEN WATER AND DISSOLVED HYDROGEN IN PRESENCE OF DIETHYLAMINE. Takanobu Ishida and Manson Benedict (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Feb. 1964. Contract AT(30-1)-2249. 331p. (MITNE-44). Dep.(mn); $7.00(cy), 7(mn) CFSTI.

The rate of exchange of deuterium between water and dissolved hydrogen was measured in the presence of diethylamine (DEA) as a homogeneous liquid-phase catalyst. The reaction rate was measured in a batch system consisting of a one-liter high-pressure autoclave, which was charged with about 500 ml of a degassed dilute solution of DEA in water containing about 25 atom percent deuterium of accurately known isotopic content. Hydrogen gas of natural isotopic content was charged to a measured pressure of about 80 atmospheres. The reaction rate was determined by comparing the thermal conductivity of gas samples taken at known times with samples of known deu-

terium content. Experiments were made at temperatures of 100, 150, and 200°C, and at DEA concentrations between 0.78 and 1.83 normal. The reaction rate was found to be proportional to the partial pressure of hydrogen and to increase with increasing temperature and amine concentration. The reaction rate varies as the 1.07 power of the amine concentration at 100°C, the 1.46 power at 150°C, and the 1.58 power at 200°C. The average activation energy of the reaction is 8.0, 7.5, 6.9, and 6.1 kcal per gram mole at total DEA concentrations of 2.0, 1.6, 1.2, and 0.8 normal, respectively. A set of reaction mechanisms were proposed to explain the observed results. At 100°C and under a hydrogen pressure of 200 atmospheres, transfer of deuterium from hydrogen to water in the liquid phase reaction HD + $H_2O \rightarrow H_2$ + HDO will proceed at a rate of 0.5 gram atoms D transferred per hour per liter of 1.64N DEA solution. This is about one-third of the rate of the same exchange reaction at this temperature and pressure when catalyzed by 1N KOH solution in place of DEA. As the rate with KOH is too slow to serve as the basis for an economic process for heavy water production, it is concluded that DEA does not have sufficient catalytic activity to serve as a practical catalyst in a dual-temperature exchange process. Tetraalkylammonium hydroxides and soluble salts of the transition elements are suggested as substances to be investigated for possibly greater activity as homogeneous catalysts. (D.L.C.)

17857 (NP-14810) BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF GASES AND GAS-CONDENSED PHASE REACTIONS. No. 13. L. Brewer, comp. (International Union of Pure and Applied Chemistry). Dec. 31, 1964. 34p.

A total of 304 references is presented on reactions of gases and condensed phases, and on spectroscopy of interest to high-temperature chemistry. (D.L.C.)

17858 (ORNL-TM-1061) SYNTHESIS AND INFRARED ABSORPTION SPECTRUM OF DIBORANE-^{10}B. H. L. Holsopple and Lucy E. Scroggie (Oak Ridge National Lab., Tenn.). Feb. 19, 1965. Contract [W-7405-eng-26]. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Essentially pure diborane-^{10}B($^{10}B_2H_6$) was prepared for the Physics Division. The compound was prepared by the incremental addition of $^{10}BF_3$-etherate to a diethyl ether solution of lithium aluminum hydride. The product was purified by fractional condensation, and its purity was established from its infrared absorption spectrum and mass spectroscopic analysis. (auth)

17859 (TID-21511) VOLTAMMETRY OF WATER AS A SOLUTE IN A MOLTEN ALKALI NITRATE SOLVENT (thesis). Thomas Edward Geckle (Pennsylvania State Univ., University Park. Dept. of Chemistry). June 1964. Contract AT(30-1)-2133. 126p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

A study was made of the "water wave" in molten equimolar KNO_3-NaNO_3 at 350°C, using a rotated Pt disk microelectrode and melts equilibrated with water vapor at partial pressures between 2 and 11 mm Hg. Sigmoid-shaped current-voltage waves were obtained with well-defined limiting current plateaus. The correct limiting currents are directly proportional to the concentration of water in the melt. A reaction mechanism is suggested in which the reduction products of water reduce the nitrate ion and water is regenerated, producing a catalytic current. A controlled-potential polarograph and its operation are described. (D.L.C.)

17860 (TID-21549) STARK EFFECTS IN PARAMAGNETIC RESONANCE (thesis). Report No. 142. Stanley Howard Christensen (Cornell Univ., Ithaca, N. Y. Materials Science Center). Sept. 1963. Contract [AT(30-1)-2179] and SD-68. 129p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Shifts, linear in applied electric field, of the magnetic energy levels of a paramagnetic ion are possible if the local environment lacks inversion symmetry. The expected angular variations and magnitudes of these Stark effects are examined for ions in tetrahedral, T_d, and trigonal, C_{3v}, symmetry, particularly as they apply to the Co^{2+} ion substitutional for Cd in cubic CdTe and hexagonal CdS. The Stark effects, recorded as shifts in the resonant magnetic field per unit of applied electric field, were measured at 4.2°K using both oscillatory and static electric fields of about 3 kv/cm, with a balanced bolometer x-band (9kMc) microwave spectrometer. For CdTe:Co, broad lines were detected by electric field modulation that were not found by the usual paramagnetic resonance techniques. These are believed to be the strain-broadened $\pm 1/2$ to $\pm 3/2$ transitions among the $S = 3/2$ states. The magnitudes of this effect and of a Stark shift of the $-1/2$ to $+1/2$ transition in CdTe:Co were in fair agreement with the predictions, but the angular dependences were not, indicating a departure from the assumed symmetry. For CdS:Co, the observed Stark shift was some 300 times larger than expected and did not reflect the hexagonal symmetry of the host crystal. Some implications of the disagreement between theory and experiment are discussed. (auth)

17861 (TID-21648) MASS SPECTROMETRIC STUDY OF LABELED NITROUS OXIDE $N^{15}N^{14}O$ (thesis). Chia Ting Chen (Leihigh Univ., Bethlehem, Pa.). 1965. 72p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

In the mass spectrum of $N^{15}N^{14}O$, there appears at mass 31 a peak whose formation may be due to unimolecular processes. An attempt was made to observe a conceivable ion-molecule reaction contributing to this peak. Appearance potentials of the several ions formed in the mass spectrum of labeled $N^{15}N^{14}O$ were measured. Though it is not too clear, there is sign that mass 31 ion is a secondary ion. Still, it is difficult to identify the ionic reactant. (auth)

17862 (UCRL-11354) OLD AND NEW PROBLEMS IN THE FIELD OF VAPOR-LIQUID EQUILIBRIA. Otto Redlich (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 6, 1964. Contract W-7405-eng-48. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A survey is presented of a few of the important contributions of various authors in the field of vapor-liquid equilibria in the last twenty years. Activity and fugacity coefficients are defined differently without trying to maintain a formal analogy. Activity coefficients of non-associating mixtures are satisfactorily represented by the traditional two-parameter relations. For associated solutions, as a rule, an association function must be superimposed. Progress in the systematic representation of interaction in solution is promising. Calorimetric measurements in recent years have made considerable contributions. (D.L.C.)

17863 (AI-Trans-76) INVESTIGATIONS CONCERNING THE CRITICAL STATE. 1. CONTRIBUTION TO THE KNOWLEDGE OF THE CRITICAL STATE OF WATER AND OF AQUEOUS SOLUTIONS. Erich Schroeer. Translated by Anthony Cornell (Atomics International, Canoga Park, Calif.), from Z. physik. Chem., 129: 79-110(1927). 36p. Dep.(mn); $3.60(fs), $1.28(mf) JCL.

An apparatus and a method are described for the investigation of the critical state of water and of aqueous solutions in the temperature-density diagram. The temperature 374.20 ± 0.20° was obtained as the most probable value of the critical temperature of water. The appearance of the critical state was observed independently of the degree of filling within the limits 0.28 and 0.39. The densities of the gas and the liquid phase are not alike at the passage through the critical temperature; homogeneity is obtained about 0.5° above. If uniformity is obtained through mixing, then new differentiation of the density occurs when mixing is discontinued. Critical opalescence was ascertained in the case of water. The solutions of alkali halides show no linear relationship between the molar concentration and the increase in the critical temperature, and likewise the increases of different but equal molar solutions are not the same. The relations are indicated by the formula: $\Delta T = x^{\frac{1}{3}} + \text{const.}$ The curve in the temperature-density diagram for solutions is stable; it shows a density-independent portion. In colored salts, it was ascertained that, in order to reach the critical temperature, the gas phase takes up only very little solid substance if the content is mixed

thoroughly. The temperatures for the disappearance of the meniscus are the same in all cases. An attempt to explain the solutions in the critical state is made. (auth)

17864 (IS-Trans-11) HYPERFINE STRUCTURE SPLITTING IN HOLMIUM ETHYLSULFATE. S. Huefner. Translated for Ames Lab., Ames, Iowa, from Z. Physik, 172: 512-19(1963). 9p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

The hyperfine structure splitting in the ground state of holmium in ethyl sulfate was determined spectroscopically. The values of $A_1 = 0.328 \pm 0.011$ cm^{-1} and $\Delta_1 = 0.07 \pm 0.04$ cm^{-1} were obtained. (auth)

17865 EXCESS TRANSPORT PROPERTIES OF LIGHT MOLECULES. John D. Rogers and F. G. Brickwedde (Los Alamos Scientific Lab., N. Mex.). A. I. Ch. E. (Am. Inst. Chem. Engrs.) J., 1: 304-10(Mar. 1965). (LA-DC-6493)

A detailed study was made of the excess viscosity of dense-phase argon, deuterium, ^{3}He, ^{4}He, para and normal hydrogen, neon, and nitrogen and of the excess thermal conductivity of normal hydrogen. A definite temperature dependence for the excess viscosity vs. density was found to exist for argon, ^{4}He, hydrogen, and nitrogen and to be indicated for deuterium. The existing thermal conductivity data for hydrogen were examined. A theoretical analysis for the qualitative behavior of excess thermal conductivity is given. The critical point viscosity values for all the species are given. Graphs, together with references to 1-atm data, are presented for computation of the transport properties. (auth)

17866 SPECTROPHOTOMETRIC STUDY OF THE SYSTEM UO_2^{2+} – $CHCl_2COO^-$. P. Spacu and Florica Popea (Sectia de Chimie Anorganica, Central de Cercetari Chimice, Academia R.P.R., Bucharest). Acad. Rep. Populare Romine Studii Cercetari Chim., 11: 353-62(1963). (In Romanian)

A study of complex formation between uranyl ion and dichloroacetate ion was carried out. The usual methods of analysis gave no conclusive results, since these methods are useful only in cases where the stability constant of the complex is large. However, application of the method of straight lines, proposed by E. Asmus, U. Hinz, K. Ohls, and W. Richley (Z. Anal. Chem., 178: 104 (1960)) indicated the formation of a weak complex. Measured amounts of 0.4M $CHCl_2COOH$-$CHCl_2COONa$ were titrated into 4 ml of 0.1M $UO_2(NO_3)_2.6H_2O$. Each solution was brought to 25 ml and the absorbances E/d = m recorded. When m^{-1} was plotted against $v^{-n}10^{-2n}$, a series of curves was obtained; of these, that for n = 3 was a straight line. From these data it was determined that a complex $UO_2(CHCl_2COO)_3^-$ is formed, and that it has a dissociation constant of 1.98×10^{-4} moles $^3/_{13}$. (BBB)

17867 THE REDUCTION OF TITANIUM (IV), VANADIUM(V), CHROMIUM(III), MOLYBDENUM(VI), TUNGSTEN (VI), URANIUM(VI) AND IRON(III) WITH SODIUM–LEAD ALLOY. R. A. Edge and G. W. A. Fowles (Univ. of Southampton, Eng.). Anal. Chim. Acta, 32: 191-4(Feb. 1965).

The reduction of Ti(IV), V(V), Cr(III), Mo(VI), W(VI), U(VI), and Fe(III) by sodium–lead alloy in mineral acids (HCl and H_2SO_4) was investigated, and quantitative reduction procedures were developed for Ti, V, Mo, U, and Fe. (M.C.G.)

17868 NEW DATA ON THE EQUILIBRIUM IN $MeS(MeS_2)$–UO_2SO_4–H_2O SYSTEMS AT HIGH TEMPERATURES AND PRESSURES. B. S. Osipov and R. P. Rafal'skii. At. Energ. (USSR), 18: 189-91(Feb. 1965). (In Russian)

Equilibrium of uranium concentrations in MeS–UO_2^{2+}–H_2O systems at 200 to 360°C was studied in order to determine the processes of uranium precipitation from hydrothermal solutions. Diagrams of uranium reduction in pyrite and galena solutions as a function of time and temperature showed that in pyrite systems the equilibrium is reached in less than 25 hr. at 200°C, and at 350°C it is reached in 11 hr. Concentration of uranium in PbS, LnS, and $CuFeS_2$ solutions diminished with rising temperature, and at 350°C it was less than 1 mg/g. Uranium concentration in FeS_2 and MoS_2 systems at 200 to 250°C was about 2 to 3 times higher than in other sulfides, however, it decreased sharply with rising temperature. It was also noticed that in sulfide solutions uranium appeared, predominantly, in the hexavalent state. (R.V.J.)

17869 STUDIES OF THE BEHAVIORS OF CARRIER-FREE RADIOISOTOPES. I. THE COPRECIPITATION OF CADMIUM-115 WITH FERRIC HYDROXIDE. Fujio Ichikawa (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 37: 1560-1(Oct. 1964).

The coprecipitation ratio of carrier-free ^{115}Cd with ferric hydroxide was measured as a function of ferric, cadmium, ammonium and other ion concentrations. When ammonium hydroxide was used as a precipitant, about half the amount of carrier-free cadmium was coprecipitated with 10 mg ferric hydroxide. This ratio increased logarithmically with the amount of precipitate. The ratio also depended on the concentration of ammonium ions at a constant pH value. When sodium hydroxide was used as a precipitant, the carrier-free cadmium was coprecipitated entirely with ferric hydroxide. (M.C.G.)

17870 THE NEAR-INFRARED ABSORPTION SPECTRA OF LANTHANIDE CHLORIDES DISSOLVED IN MOLTEN LiCl–NaCl–KCl EUTECTIC. Masato Mamiya (Government Chemical Industrial Research Inst., Tokyo). Bull. Chem. Soc. Japan, 38: 178-83(Feb. 1965).

Using a high-temperature cell for molten salts, a spectrophotometric investigation in the near-infrared region from 0.8 to 2.6 μ and at temperatures from 400 to 800°C was carried out with fourteen lanthanide chlorides dissolved in a LiCl-NaCl-KCl mixture of eutectic composition (49.0–17.3–33.7 mol.%, mp 333°C). Praseodymium, neodymium, samarium, dysprosium, holmium, erbium, thulium, and ytterbium had characteristic absorption bands in this region. Most of the near-infrared absorption bands of lanthanide chlorocomplexes were compared to similar spectra obtained in molten nitrate media. However, the several absorption bands were found to be different in molten nitrate and chloride eutectics. Thus, the absorption bands of europium and terbium were observed in nitrate, whereas their bands were not found in chloride, and the absorption bands of praseodymium, samarium, and holmium beyond the 1.4 μ range were found to be located at different wavelengths. These solvent effects can be attributed to the existence of a different lanthanide complex in each solvent, for the ligand field affects the 4f-electronic energy levels of the above elements. The absorption peaks of lanthanide ions decreased as the temperature increased, partly due to the change in the concentration of the ions associated with the volume change. However, all the characteristic absorption bands of lanthanide in the near-infrared region had stable molar absorptivities at a constant temperature. (auth)

17871 A DEUTERON MAGNETIC RESONANCE STUDY OF UREA-D_4. Takehiko Chiba (Tokyo Univ.). Bull. Chem. Soc. Japan, 38: 259-63(Feb. 1965).

A deuteron magnetic resonance study was made on a single crystal of urea-d_4. At room temperature deuteron quadrupole coupling corresponding to a stationary molecule was obtained. The eqQ and η values determined were: eqQ/h = 210.8 ± 1.0 kc/sec and $\eta = 0.139 \pm 0.010$ for D_1, and eqQ/h = 210.7 ± 1.0 kc/sec and $\eta = 0.146 \pm 0.010$ for D_2 at room temperature, and eqQ/h = 206.3 ± 1.2 kc/sec, $\eta = 0.138 \pm 0.010$ for D_2 at 117°C. In both cases the maximum field gradient component and the N–H direction were in good agreement. The onset of reorientational motion about the C = O bond of a whole molecule was concluded from the line-width change at high temperatures. Above 110°C the effect on the line-width of the reorientation about C–N bond was also observed. The barrier heights for these motions were estimated to be 11 ± 2 kcal mol for the reorientation about the C = O bond and 15 ± 3 kcal/mol for that about the C–N bond. The temperature dependence of the quadrupole splitting and that of the dipole coupling between ^{14}N and D

were observed and discussed in relation to the motion of the urea molecule. (auth)

17872 CARBON-13 ISOTOPE EFFECTS IN SYSTEMS CONTAINING CARBON DIOXIDE, BICARBONATE, CARBONATE, AND METAL IONS. H. G. Thode, M. Shima, C. E. Rees, and K. V. Krishnamurty (McMaster Univ., Hamilton, Ont.). Can. J. Chem., 43: 528-95(Mar. 1965).

The fractionation of ^{13}C between $CO_2(g)$ and $CO_3^{=}$–$HCO_3^{-}(aq)$ in solution was studied in single stage experiments using carbonic anhydrase to catalyze the hydration of CO_2. Added metal ions, pH of the equilibrium mixture, and temperature were found to play important roles in the overall fractionation process. Theoretical evaluation of the $^{13}CO_2(g)$ — $^{12}CO_3^{-}(aq)$ equilibrium constant (K_2) was made using the most recent spectroscopic data on the exchanging species. Variation of the equilibrium constant K_2 with temperature was calculated for each 25 degree interval from 0 to 975°C with the help of the McMaster University IBM 7040 computer. It is shown that the overall ^{13}C fractionation in the system may be treated as contributions due mainly to three exchange equilibria whereby $^{13}CO_2(g)$ independently exchanges with $^{12}CO_2(aq)$, $H^{12}CO_3^{-}(aq)$, and $^{12}CO_3^{=}(aq)$, the corresponding equilibrium constants being K_0, K_1, and K_2 respectively. The best fit values for the equilibrium constants are $K_0 = 1.0009$, $K_1 = 1.0077$, and $K_2 \geq 1.013$, indicating the order $K_0 < K_1 < K_2$. (auth)

17873 THE CHEMISTRY OF XENON. John G. Malm (Argonne National Lab., Ill.), Henry Selig, Joshua Jortner, and Stuart A. Rice. Chem. Rev., 65: 199-236(Apr. 1965).

All experimental and theoretical works on the chemistry of xenon published through June 1964 are reviewed. The study of xenon chemistry is limited to the stable fluorides and their complexes, two unstable oxides, and the aqueous species derived from the hydrolysis of the fluorides. The nature of the chemical bond in xenon fluorides is discussed. Interpretations of physical properties are considered, along with excited electronic states. Theoretical models are discussed. (183 references). (M.C.G.)

17874 IONIZING REACTIONS OF NOBLE GAS ATOMS IN METASTABLE STATES WITH POLYATOMIC MOLECULES. V. Cermak and Z. Herman (Inst. of Physical Chemistry, Czechoslovak Academy of Sciences, Prague). Collection Czech. Chem. Commun., 30: 169-94(Jan. 1965).

Ionization and fragmentation of methane, ethane, propane, n-butane, ethylene, acetylene, methanol, and ethanol were investigated in collisions with excited noble gas atoms in metastable states. A special ion source with separated excitation and collision regions was used in these studies. The noble gas atoms were excited by electron impact and the positive ions, formed in the collision region, were analyzed by means of a mass spectrometer. The abundances of parent and fragment ions resulting from these collisions were determined. In those cases where break-down curves for the particular ion were known, the probable excitation energy distribution in the molecular ion was determined, using an indirect procedure. In some cases it was possible to exclude some ambiguous values of the appearance potentials of ions. The collision cross sections are of the order of 10^{-15} cm^2 and increase with increasing molecular size. The important feature of ionization of polyatomic molecules by excited noble gas atoms was that a higher amount of energy was transferred to the molecules than in ionization by electrons of the same energy. (auth)

17875 ADSORPTION AND CATALYTIC REACTIONS ON EVAPORATED METAL FILMS. XI. ADSORPTION AND INTERACTION OF HYDROGEN AND OXYGEN ON RHODIUM. V. Ponec, Z. Knor, and S. Cerny (Inst. of Physical Chemistry, Czechoslovak Academy of Sciences, Prague). Collection Czech. Chem. Commun., 30: 208-16 (Jan. 1965).

Adsorption of hydrogen and oxygen and their interaction were studied on evaporated films of rhodium. The extent of hydrogen and oxygen adsorption as well as changes of electric resistance accompanying the adsorption and the interaction of both gases were measured. These quantities were also followed during the sorption of hydrogen atomized in the gas phase. (auth)

17876 KINETICS OF THE REACTION BETWEEN SODIUM FLUORIDE AND URANIUM HEXAFLUORIDE. I. Peka (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 30: 217-22(Jan. 1965).

The kinetics and thermometry of the reaction between NaF and UF_6 are described at temperatures of 80 to 200°C. Chemisorption of uranium hexafluoride on the surface of pulverized NaF took place in the first phase of the reaction. The rate of chemisorption did not change practically with temperature. The second reaction phase was governed by a parabolic law. An activation energy of 5.6 ± 0.5 kcal/mol was calculated for this phase. At higher temperatures formation of compounds richer in uranium was observed then corresponds to the composition of the known complex $UF_6.3$ NaF. (auth)

17877 ^1H–{^{14}N} MAGNETIC DOUBLE RESONANCE SPECTROMETER. Hirotake Kamei. Denki Shikensho Iho, 28: 591-600(Aug. 1964). (In Japanese)

An experiment was made on a nuclear magnetic double resonance involving the irradiation of ^{14}N, and the proton magnetic resonance spectrum was observed at 40 Mc/s. The second radiofrequency field was supplied with a variable frequency oscillator (VFO) using a Clapp circuit. The putput of the VFO was fed to a driver stage followed by a power amplifier. The power amplifier utilized an 807 beam transmitting tube. The output of the power amplifier was coupled to the input jack of a double resonance probe. The probe head housed a sample coil for proton resonance (L_1) and an additional irradiation coil for ^{14}N resonance (L_2). The coil L_1 was wound on a glass tube set in a Dewar tube. The coil L_2 was divided into two sections and wound on the Dewar tube, so that the coil L_1 and the coil L_2 assembly had the same geometric center. Since dielectric loss of the large second radiofrequency power in the liquid sample raised its temperature, the sample-temperature was controlled by streaming nitrogen of fixed temperature through the Dewar tube. The double resonance spectra of protons in formamide and pyridine were measured as a function of the frequency of second radiofrequency field at constant intensity and as a function of the second radiofrequency field intensity at ^{14}N resonance frequency. From the first measurement the ^{14}N resonance frequencies for formamide and pyridine were found to be 2889513 ± 15 and 2890108 ± 20 c/s, respectively. The completely decoupled spectra were obtained for formamide, pyridine, and picolines. The signal due to formyl proton of formamide appeared as a quartet and the signal of the amine protons contained six lines. The decoupled spectrum for pyridine was in good agreement with the previously calculated spectrum. The ^{14}N resonance shift between formamide and pyridine was found to be 206 ± 13 ppm. (auth)

17878 COMPLEX FORMATION IN THE SYSTEM LANTHANUM–BORONALIZARINIC COMPLEX-O-OXYQUINOLINE. L. S. Serdyuk and S. M. Lazorina (Dnepropetrovsk State Univ., Ukrainian SSR). Dopovidi Akad. Nauk Ukr. RSR, No. 12, 1621-4(1964). (In Ukrainian)

It was established that during interaction of lanthanum with a boron alizarinic complex and o-oxyquinoline a mixed complex is formed having a maximum adsorption at a wavelength of 540 mμ. The composition of the complex was determined at pH 9.6 by methods of isomolar series and shift in equilibrium. On the basis of data obtained, the experimentally established facts of the composition of the complex may be expressed by the formula $La(Ox)_2Alis \cdot HOx$ where Ox and Alis are anions of o-oxyquinoline and alizarin S. (auth)

17879 FABRICATION OF THORIUM OXIDE FUEL ELEMENT. I. THERMAL DECOMPOSITION OF THORIUM OXALATE AND PARTICLE SIZE GROWTH OF THORIUM OXIDE BY HEATING. Hideo Kinoshita and Shigeo Aoki (Furukawa Electric Co., Ltd., Japan). FAPIG (Tokyo), No. 30, 378-83(Feb. 1964). (In Japanese)

The effect of the precipitation temperature on the parti-

cle size distribution of thorium oxalate powder prepared by the reaction between commercial thorium nitrate and oxalic acid was studied. The lower the temperature, the smaller were the sizes and the narrower was the size distribution of the powder particles. The thorium oxalate was heated in air, carbon dioxide, and hydrogen at temperatures from 120 to 800°C, and was studied by differential thermal analysis and by thermal gravimetric analysis. It was found from the TGA curves that the DTA peaks at 250 and 360°C correspond to the disappearance of one out of the two molecules of water of crystallization and to the change from the oxalate to the oxide, respectively. The DTA for heating in carbon dioxide and hydrogen showed no peaks for the exothermic reaction, which were observed in heating in air. The changes in the average particle size, the size distribution, the packing density, the specific surface area and the average grain size were observed, by means of x-ray diffraction, electron microscope, and BET, in the sintering temperature range of 600 to 1400°C. The specific surface area reached a maximum at 350°C and then decreased with increasing temperature. A drastic change in the contraction rate was observed for the particles at 800°C, indicating the beginning of intra-particle sintering. (Nucl. Sci. Abstr. Japan, 3: (Nov. 1964))

17880 COMPLEX FORMATION OF LIGHT LANTHANONS WITH SODIUM TRIPHOSPHATE. S. K. Kundra, P. R. Subbaraman, and J. Gupta (National Chemical Lab., Poona, India). Indian J. Chem., 3: 60-2(Feb. 1965).

The trivalent lanthanons were found to combine with triphosphate in aqueous solution in the pH range 3 to 4 to give complexes of the type $LnHP_3O_{10}^-$. The formation constants ($\log K_f$) of the complexes of lanthanum, praseodymium, neodymium, samarium, and europium at $\mu = 0.3$ and a temperature 30° ± 1°C, were found to be 6.61 ± 0.04, 6.98 ± 0.04, 7.15 ± 0.03, 7.42 ± 0.03, and 7.46 ± 0.04, respectively, as determined from cation-exchange equilibrium data. A praseodymium complex salt of the formula $NaPrHP_3O_{10}\cdot 3H_2O$ was isolated from a solution of pH 3.5, indicative of hexacoordinated structure. (auth)

17881 THERMAL DECOMPOSITION OF CEROUS OXALATE AND ITS MAGNETIC BEHAVIOR. O. K. Srivastava and A. R. Vasudeva Murthy (Indian Inst. of Science, Bangalore, India). Indian J. Chem., 3: 86(Feb. 1965).

Magnetic susceptibility of the residues obtained during thermal decomposition of cerous oxalate decahydrate at several temperatures was measured by the Gouy method. The results indicated an increase in the gram susceptibility of the residue with decrease in the extent of hydration. Decomposition of the oxalate and the resultant decrease in the carbonaceous species of the residue increased the value of the gram susceptibility up to 350°C. Formation of ceric oxide from cerous oxalate could be inferred from the fall in the magnetic susceptibility values beyond 400°C. (auth)

17882 IRON(II) + IRON(III) ISOTOPE EXCHANGE IN DIMETHYL SULFOXIDE. J. Menashi, W. L. Reynolds, and G. Van Auken (Univ. of Minnesota, Minneapolis). Inorg. Chem., 4: 299-304(Mar. 1965).

The isotope exchange reaction between iron(II) and iron(III) in dimethyl sulfoxide was studied. The reaction is first order with respect to total Fe(II) and to total Fe(III) concentration. The enthalpy and entropy of activation are 9.6 ± 0.6 kcal/mole and −20 ± 2 cal/deg mole, respectively. The reaction was studied at various perchloric acid concentrations and ionic strengths and over the entire range of water concentrations from zero added water to purely aqueous solutions. At water concentrations less than approximately 0.1 to 0.2M and at perchloric acid concentrations greater than approximately 7×10^{-6}M, the reaction appeared to proceed between the hexakis(dimethyl sulfoxide)iron(II) and (III) complexes. (auth)

17883 METAL-METAL BONDING IN $[Re_2X_8]^{2-}$ IONS AND OTHER METAL ATOM CLUSTERS. F. A. Cotton (Massachusetts Inst. of Tech., Cambridge). Inorg. Chem., 4: 334-6(Mar. 1965). (MIT-1965-12)

The metal-metal bonding in the $[Re_2X_8]^{2-}$ ions was treated by a simple MO method similar to that previously used for other metal atom cluster compounds. A quadruple bond between the rhenium atoms is proposed and it is shown that this accounts for the eclipsed rotomeric configuration. The assignment of the absorption spectrum of $[Re_2Cl_8]^{2-}$ species is discussed. The consistency of observed bond lengths with the calculated bond orders for all of the known halo metal atom cluster compounds is demonstrated. (auth)

17884 ELECTRON SPIN RESONANCE IN THE PENTACHLOROMETHOXONIOBATE(IV) ION. P. G. Rasmussen, H. A. Kuska, and C. H. Brubaker, Jr. (Michigan State Univ., East Lansing). Inorg. Chem., 4: 343-5(Mar. 1965). (COO-1001-1)

Electron spin resonance at 3.2 cm was observed from the $Nb(OCH_3)Cl_5^{2-}$ ion in dilute methanol solution saturated with HCl. Measurements were made at 300 and at 77°K, and both the isotropic and anisotropic g values and hyperfine splittings due to the ^{93}Nb (100%) nucleus were observed. The results were interpreted in terms of an approximate molecular orbital approach to the bonding, which takes into account the effect of charge-transfer states. (auth)

17885 PRESSURE AND POLYMORPHISM IN THE RARE EARTH SESQUIOXIDES. James O. Sawyer, Bruce G. Hyde, and LeRoy Eyring (Arizona State Univ., Tempe). Inorg. Chem., 4: 426-7(Mar. 1965).

The effects of pressure on polymorphic forms of Sm_2O_3, Pr_2O_3, Dy_2O_3, Ho_2O_3, Er_2O_3, Tm_2O_3, Yb_2O_3, Lu_2O_3, Y_2O_3, and Nd_2O_3 were studied. Only two transformations were observed after a pressure of $3 \pm 1 \times 10^5$ atm: C-type Pr_2O_3 was completely converted to the A modification and C-type Ho_2O_3 was partly (~20%) converted to the B form. (M.C.G.)

17886 THE EXCHANGE REACTION OF ETHYL IODIDE AND IODINE. Edward D. Cohen and C. N. Trumbore (Univ. of Delaware, Newark). J. Am. Chem. Soc., 87: 964-72(Mar. 5, 1965). (TID-20960)

The thermal-exchange reaction of ethyl iodide and iodine was investigated in the liquid phase. The exchange rate was independent of iodine concentration from 10^{-6} to 10^{-3}M and had an average value of 0.50×10^{-6} M/hr in CCl_4 solvent at 23°C. The over-all exchange rate was dependent on ethyl iodide concentration and may be expressed by $R_{ex} = k(EtI)^2$. This rate law was applicable from 0 to 40°C with an activation energy of 22 kcal/mole. Isopropyl iodide was found to exchange at a significantly lower rate. The rate-controlling step was postulated to be the slow formation of diethyl iodonium iodide followed by a fast attack of iodine on the iodonium iodide whose decomposition leads to exchange. The implications of this study on the radiolysis reaction of ethyl iodide are discussed. (auth)

17887 VACUUM DISTILLATION OF LiF. A. J. Singh (Atomic Energy Establishment, Trombay, India), R. G. Ross, and R. E. Thoma. J. Appl. Phys., 36: 1367-70(Apr. 1965). (ORNL-P-460)

Vacuum distillation methods were demonstrated to be effective for producing high-purity crystals of LiF. It was established from chemical analyses of condensate products that under the experimental conditions adopted, 995°C and 4 to 5×10^{-2} torr, the order of vaporization for the fluorides, NaF, MnF_2, LiF, MgF_2, and CaF_2, corresponds to the order of their decreasing vapor pressures. Under similar experimental conditions LiF containing no more than 200 ppm of oxygen could be produced from mixtures of LiF and Li_2O. (auth)

17888 REACTIONS OF ZIRCONIUM t-BUTOXIDE WITH ACETYL CHLORIDE AND ZIRCONIUM TETRACHLORIDE WITH t-BUTYL ACETATE. R. C. Mehrotra and R. A. Misra (Univ. of Rajasthan, Jaipur, India). J. Chem. Soc., 43-6(Jan. 1965).

The reactions of zirconium tetra-t-butoxide with acetyl chloride were studied. The replacement of the first t-butoxide group was slow, but with further replacement side reactions occurred resulting in the formation of acetate derivatives. The conclusion was confirmed by a detailed study of the reactions between zirconium tetrachloride and t-butyl acetate in different stoichiometric ratios. A mechanism for the reaction is suggested. (auth)

17889 LIQUID METALS. PART X. SOLUTIONS OF HYDROGEN IN LIQUID SODIUM. C. C. Addison, R. J. Pulham, and R. J. Roy (Univ. of Nottingham, Eng.). J. Chem. Soc., 116-21(Jan. 1965).

A technique is described whereby known quantities of hydrogen are removed successively from a mixture of sodium hydride in a large excess of liquid sodium. While the hydride is present as a separate phase, the equilibrium hydrogen pressure remains constant at a value corresponding to the dissociation pressure of the hydride. The equilibrium pressure decreases as soon as the hydrogen content of the system falls below that required to saturate the liquid sodium. By this means, the solubility of hydrogen was determined at 250, 300, 315, and 330°C; it increased rapidly with increasing temperature. Equilibrium hydrogen pressures over unsaturated solutions, of known composition, of hydrogen in sodium were also measured, and the results used to determine relevant free-energy values. (auth)

17890 PROTACTINIUM(V) SULPHATES AND SELENATES. K. W. Bagnall, D. Brown, and P. J. Jones (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chem. Soc., 176-81(Jan. 1965).

A protactinium(V) acid trisulfato complex, $H_3PaO(SO_4)_3$, and the corresponding triselenato complex, $H_3PaO(SeO_4)_3$ were prepared. Some x-ray diffraction and infrared data are reported for these compounds. The sulfato complex decomposed to $HPaO(SO_4)_2$ at 375°C. Preparation of potassium sulfatoprotactinates(V) from aqueous solution was also attempted. (auth)

17891 IODO-COMPLEXES OF THORIUM(IV) AND URANIUM(IV). K. W. Bagnall, D. Brown, P. J. Jones, and J. G. H. du Preez (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chem. Soc., 350-3(Jan. 1965).

Complexes of the type $R_2M^{IV}I_6$ where R = Bu_4N^+ (tetrabutylammonium) or Ph_4As^+ (tetraphenylarsonium), and M^{IV} = Th or U and the adduct $ThI_4,4CH_3CN$ were prepared by reactions in anhydrous methyl cyanide. Magnetic properties are reported for tetraphenylarsonium hexaiodouranate(IV) and hexachlorouranate(IV). (auth)

17892 DEUTERIUM ISOTOPE EFFECT IN OCTAHEDRAL SUBSTITUTIONS. PART I. THE AQUATION OF CIS- AND TRANS-DICHLORO- AND CIS- AND TRANS-CHLORONITRO-BIS(ETHYLENEDIAMINE)COBALT(III) CATIONS. S. C. Chan (Univ. of Hong Kong, China). J. Chem. Soc., 418-25(Jan. 1965).

The rate constants for the solvolytic aquation of cis- and trans-dichloro- and cis- and trans-chloronitro-bis(ethylenediamine)cobalt(III) cations were determined in both aqueous and deuterium oxide solutions. The rates in deuterium oxide solutions were lower than those in aqueous solutions and the rate reductions were virtually independent of the nature and position of the orienting ligand. These determinations were repeated with N-deuterated complexes and it was found that the rate reductions for the chloronitro complexes were significantly smaller than those for the dichloro complexes, showing that the decrease in rate was greater for S_N1 than for S_N2 aquations. The observations were similar to those in the solvolysis of organic halides. The steric courses for the aquation of the N-deuterated complexes were also measured in aqueous solutions and it is found that bimolecular aquations of both the cis- and trans-complexes, as well as unimolecular aquation of the cis-complex proceed with complete retention of configuration, whereas unimolecular aquation of the trans-complex yields a mixture of isomers directly. The products of the aquation of the dichloro-complexes isomerized to equilibrium mixtures at rates comparable with those of their formation, and it was necessary to determine the rate of isomerization and the position of equilibrium of the N-deuterated aquochloro-cations in aqueous solutions in order to make corrections in the steric course determinations. (auth)

17893 SOME ALKYLBERYLLIUM HYDRIDE COMPLEXES, AND THE INFRARED ABSORPTION OF SOME BERYLLIUM HYDRIDES AND DEUTERIDES. N. A. Bell and G. E. Coates (Univ. of Durham, Eng.). J. Chem. Soc., 692-9(Jan. 1965).

The salts $NaMe_2HBe$, $NaMe_2DBe$, $NaEt_2HBe$, and $NaEt_2DBe$ (where Me = methyl and Et = ethyl) react with beryllium chloride to give mixed alkylberyllium hydrides from which coordination complexes can be obtained, e.g., $(MeHBe,NMe_3)_2$, formulated with a BeH_2Be bridge, and an insoluble involatile apparently polymeric tetramethylethylenediamine complex. Ethylberyllium hydride was also prepared from diethylberyllium and triethylstannane in diethyl ether; it yielded a dimeric amine derivative, $(EtHBe,NMe_3)_2$. Methylberyllium hydride disproportionates when heated, evolving dimethylberyllium and leaving a hydride-rich residue. The disproportionation of ethylberyllium hydride is catalyzed by the salt $NaEt_2HBe$. By comparison of the infrared spectra of $(MeHBe,NMe_3)_2$, $(EtHBe,NMe_3)_2$, and $(MeDBe,NMe_3)_2$, a strong absorption due to the BeH_2Be bridge was identified at 1333 to 1344 cm^{-1} (in cyclohexane). (auth)

17894 THE HALIDES OF NIOBIUM AND TANTALUM. PART VIII. THE DENSITIES, VISCOSITIES, AND SELF-IONIZATION OF NIOBIUM AND TANTALUM PENTAFLUORIDES. Fred Fairbrother, Kenneth H. Grundy, and Alan Thompson (Univ. of Manchester, Eng.). J. Chem. Soc., 761-5(Jan. 1965).

The densities and viscosities of molten niobium and tantalum pentafluorides were measured over a range of temperatures. The densities at the melting points are: NbF_5, $d_4^{80.0} = 2.6955$; TaF_5, $d_4^{95.1} = 3.8800$. The dynamic viscosities at the melting points are, respectively, 91.41 and 70.31 centipoises. The results, in conjunction with previously reported conductivities, indicated self-ionization of the melt of less than 1% and an association of the molecules into polymeric units. (auth)

17895 THE HALIDES OF NIOBIUM AND TANTALUM. PART IX. DIMETHYL ETHER, DIETHYL ETHER, DIMETHYL SULPHIDE, DIETHYL SULPHIDE, AND TETRAHYDROTHIOPHEN COMPLEXES OF THE PENTAFLUORIDES. Fred Fairbrother, Kenneth H. Grundy, and Alan Thompson (Univ. of Manchester, Eng.). J. Chem. Soc., 765-70(Jan. 1965).

The following 1:1 complexes were prepared and their compositions established by analysis and vapor pressure studies: NbF_5, Me_2O; TaF_5,Me_2O; NbF_5,Me_2S; TaF_5,Me_2S; NbF_5,Et_2O; TaF_5,Et_2O; NbF_5,Et_2S; TaF_5,Et_2S (where Me = methyl and Et = ethyl). All of them can be distilled unchanged at low pressures. The first four are solid at room temperature and melt below 100°; the remaining four are liquids. The dimethyl sulfide adducts also sublime below their melting points. Vapor pressure studies indicated in addition the existence, at lower temperatures, of 1:2 adducts with dimethyl ether and dimethyl sulfide. Tetrahydrothiophen formed, with both pentafluorides, 1:2 adducts which melted below 100° with decomposition. Measurements were made of the densities, viscosities, and electrical conductivities of molten diethyl ether and diethyl sulfide adducts; these indicated some degree of polymerization and ionization. (auth)

17896 THORIUM OXYIODIDE. D. E. Scaife, A. G. Turnbull, and A. W. Wylie (Commonwealth Scientific and Industrial Research Organization, Melbourne). J. Chem. Soc., 1432-7(Feb. 1965).

Preparation of thorium oxyiodide was investigated by differential thermal analysis, and the compound was examined by x-ray diffraction, optical and electron microscopy, and spectroscopy in the visible and infrared regions. A strong exothermal reaction occurred between thorium oxide and molten thorium tetraiodide. The heat of formation, based on heat of solution in hydrochloric acid, was -237.4 ± 1.0 kcal/mole. Comparison with other oxyhalides of thorium showed that there is a steady increase in stability from oxyiodide to oxyfluoride against disproportionation to oxide and gaseous tetrahalide. A useful relationship between the heat of formation of the oxyhalides and the heat of the disproportionation gave the heat of for-

mation of thorium oxybromide as −268.4 ± 2 kcal/mole. Thorium oxyiodide underwent no phase or other thermal transformations when heated in a closed system to 950°C. There was no evidence of a "thoryl" group, and the characteristic physical properties of the oxyiodide are attributed to the existence of an infinite chain of thorium and oxygen atoms $(-\overset{|}{\underset{|}{Th}}-O-\overset{|}{\underset{|}{Th}}-O-)_n$. (auth)

17897 LIQUID METALS. PART XI. THE WETTING OF CHROMIUM, MOLYBDENUM, AND TUNGSTEN BY LIQUID SODIUM. C. C. Addison and E. Iberson (Univ. of Nottingham, Eng.). J. Chem. Soc., 1437-40(Feb. 1965).

Receding contact angles for liquid sodium on molybdenum and tungsten surfaces in an argon atmosphere were studied as a function of time and temperature. Each metal showed a critical wetting temperature of 160°C, below which contact angles remained above 90°C. Above 160°C complete wetting occurred, and the rate of wetting increased in a regular manner with increasing temperature. Qualitative observations at a chromium surface indicated similar behavior. The results were consistent with a mechanism in which the surface film of oxide (Cr_2O_3, MoO_2, or WO_3) was reduced to the metal by liquid sodium. (auth)

17898 POLAROGRAPHIC STUDIES OF URANIUM IN ALPHA-HYDROXY-ISOBUTYRATE MEDIUM. Wen-Kuei Wong and Kuan Pan (National Taiwan Univ., Taipai). J. Chinese Chem. Soc. (Taiwan), 7: 20-32(May 1960).

After addition of uranyl perchlorate to α-hydroxyisobutyric acid (HA) solution in sunlight, a photoreduction phenomenon was observed. Over the pH range of 4.5 to 6, the color of the solution changed gradually from yellow to greenish, and then precipitation of reddish products took place. Preliminary tests indicated that the photoreduction of U(VI) to U(IV) and then to U(III) was accompanied by decarboxylation of α-hydroxyisobutyric acid to acetone. Quantitative information for the reactions was sought and some physicochemical data from the spectrophotometric, polarographic, and reaction rate measurements were obtained. Uranyl perchlorate in aqueous solution containing HA and sodium perchlorate was studied by polarography at varying pH's. Two reduction waves with half-wave potentials at −0.22 and −0.95 v, observed at pH below 3.0, were attributable to the polarographic reductions, $UO_2^{++} + e \rightarrow UO_2^+$ and $UO^{++} + e \rightarrow UO^+$, or $UOOH^+ + e \rightarrow UOOH$. The first wave observed above pH 3.0, or in large excess of HA above pH 2.0, was attributable to the reduction of UO_2A^+ complex and a third wave at −1.2 v to that of UOA^+ complex or its dimer. A confirmation for the latter was made by polarographic reduction of uranous sulfate in HA and $NaClO_4$ solution. (BBB)

17899 CHELATE FORMATION BETWEEN THORIUM (IV) AND p-NITROBENZENEAZOCHROMOTROPIC ACID (CHROMOTROPE 2B): SPECTROPHOTOMETRIC AND ELECTRICAL CONDUCTANCE STUDIES. Suresh C. Srivastava and Arun K. Dey (Univ. of Allahabad, India). J. Indian Chem. Soc., 41: 777-82(Nov. 1964).

Spectrophotometric and electric conductance studies were made with a view to investigating the composition and stability of the chelate formed between thorium (IV) and p-nitrobenzeneazochromotropic acid (Chromotrope 2B). The composition of the purple-colored chelate (λ_{max} 550 mμ), as established by a number of methods, was 1:2 (metal: chelating agent). The chelate was stable between pH3.2 and 7.2. Tentative suggestions on the position of the chelate rings are made. (auth)

17900 SOME PHYSICAL AND CHEMICAL PROPERTIES OF ELEMENT 118 (Eka-Em) AND ELEMENT 86(Em). A. V. Grosse (Temple Univ., Philadelphia). J. Inorg. Nucl. Chem., 27: 509-19(Mar. 1965).

Various physical properties of eka-emanation (element 118) and emanation (element 86) were derived from Van der Waal's theorem of corresponding states for noble gases. The properties include crystal lattice parameters and unit cell dimensions, density and atomic volume of solid and liquid from 0°K to the critical point, critical parameters, vapor pressure of solid and liquid, heat content, heats of sublimation, vaporization and fusion, and a number of others. The chemical properties and compounds of the two elements are discussed. (auth)

17901 LATTICE ENERGIES OF IONIC CRYSTALS. I. GROUP IIa HALIDES. A. Finch and P. J. Gardner (Univ. of London). J. Inorg. Nucl. Chem., 27: 535-9(Mar. 1965).

Self-consistent values of the lattice energies of Group IIa halides were calculated by application of a Born-Haber cycle and a solvation enthalpy cycle. Combined solvation enthalpies of these ions are shown to be simple functions of anion radius and lyotropic number. (auth)

17902 COMPOSITION DIAGRAMS FOR CRYSTAL GROWTH FROM MOLTEN OXIDES. M. Schieber (Harvard Univ., Cambridge, Mass.). J. Inorg. Nucl. Chem., 27: 553-7(Mar. 1965).

Composition diagrams showing approximate boundaries in which various crystals can be grown were determined in several systems for several heating temperatures. These systems include $Mo\,O_3-Ga_2O_3-Sm_2O_3$, $PbO/PbF_2-Ga_2O_3-Sm_2O_3$, $PbO/Pb\,F_2-Fe_2O_3-Sm_2O_3$, $B_2O_3-Fe_2O_3-Li_2O$, and $Mo\,O_3-Gd_2O_3-Na_2O$. (auth)

17903 PHASE EQUILIBRIA IN THE SYSTEM $CsF-ZrF_4$. G. D. Robbins, R. E. Thoma, and H. Insley (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 27: 559-68(Mar. 1965). (ORNL-P-214)

The phase equilibrium diagram of the condensed system $CsF-ZrF_4$ was constructed from a combination of results obtained using thermal analysis, visual observation of crystallizing fluoride mixtures, and quenching techniques. Phase identification was accomplished by petrographic and x-ray diffraction analysis. In the system $CsF-ZrF_4$ three intermediate compounds were isolated and identified: Cs_3ZrF_7, Cs_2ZrF_6, and $CsZrF_5$. The compounds Cs_3ZrF_7 and $CsZrF_5$ melted congruently at 784 and 518°C respectively; Cs_2ZrF_6 melted incongruently to Cs_3ZrF_7 and liquid at 530°C. Polymorphism was exhibited by Cs_2ZrF_6 and $CsZrF_5$, the latter compound showing a markedly exothermic inversion on cooling below 330°C. Crystals of the high-temperature equilibrium forms of Cs_2ZrF_6 and $CsZrF_5$ were not retained on quenching; crystallographic verification of liquid–solid transitions was therefore unobtainable in the low-melting region of the system. The phase Cs_3ZrF_7 was observed to vary in composition. As a homogeneous single phase, the solid solution extended to the composition $80CsF-20ZrF_4$ (mole %). The x-ray diffraction data obtained from single crystals of the stoichiometric phase revealed that the compound is face-centered cubic with α_0 = 9.70 Å, and the space group is $F\bar{4}3m$, F432, or Fm3m. This compound was apparently isotypic with K_3ZrF_7, $(NH_4)_3ZrF_7$, and K_3UF_7 as regards the metal ions, but no deduction could be made as to the exact arrangement of the fluoride ions. (auth)

17904 STABILITY CONSTANTS OF LIGHTER LANTHANIDE(III) CHLORIDE COMPLEXES BY A POTENTIOMETRIC METHOD. T. Goto and M. Smutz (Ames Lab., Ames, Iowa). J. Inorg. Nucl. Chem., 27: 663-71(Mar. 1965). (IS-958).

The stability constants for the formation of $LaCl^{2+}$, $PrCl^{2+}$, and $SmCl^{2+}$ were obtained potentiometrically at an ionic strength of 1.0M and at 25.0°C in a $NaClO_4$ medium. The values were 1.60 ± 0.03, 1.58 ± 0.05, 1.62 ± 0.04, and 1.62 ± 0.06 for La, Pr, Nd, and Sm, respectively. It is shown that from a statistical viewpoint there is no significant difference among the values obtained. (auth)

17905 INFRA-RED SPECTRA OF INORGANIC ACIDS IN TRI-N-BUTYL PHOSPHATE SOLUTIONS AS A FUNCTION OF WATER CONCENTRATION. J. H. Miles (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 27: 711-15(Mar. 1965).

The infrared absorption spectra of approximately 1M $HClO_4$, HCl, and H_2SO_4 in TBP solution were obtained for water concentrations between zero and saturation. The spectra showed that the addition of one equivalent of water removes bands characteristic of the anhydrous acids and

that the absorption bands due to this water are displaced compared with water in TBP. An apparent shift in the CH_3 symmetric absorption band at 1385 cm^{-1} was noted in the H_2SO_4 solutions. (auth)

17906 DIRECT CONVERSION OF $Na_2U_2O_7$ TO UO_2 WITH H_2. E. A. Tomic (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Inorg. Nucl. Chem., 27: 744-6(Mar. 1965).

It was found that $Na_2U_2O_7$ can be reacted directly with hydrogen above 600°C to give UO_2, NaOH, and H_2O. The NaOH is removed by vaporization in the hydrogen stream. (M.C.G.)

17907 THE REACTIONS OF NIOBIUM AND TANTALUM PENTACHLORIDES WITH TRIPHENYLPHOSPHINE AND TRIPHENYLARSINE OXIDES. D. B. Copley, F. Fairbrother, and A. Thompson (Univ. of Manchester, Eng.). J. Less-Common Metals, 8: 256-61(Apr. 1965).

The reactions of niobium and tantalum pentachlorides with excess of triphenylphosphine oxide, triphenylarsine oxide, or their hydrogen peroxide adducts, were similar to the reactions of these pentahalides with sulfoxides, in that they involved abstraction of oxygen from the oxides, to form metal oxytrichlorides to which additional molecules of the undecomposed ligand were coordinated. The coproducts of the reactions were dichlorotriphenylphosphine and dichlorotriphenylarsine respectively. When the triphenylphosphine hydrogen peroxide adduct was used as a reactant however, the dichlorotriphenylphosphine was quantitatively oxidized with liberation of chlorine gas; by contrast, dichlorotriphenylarsine was not oxidized and could be isolated from the reaction with the triphenylarsine hydrogen peroxide adduct. Tantalum pentabromide underwent a similar reaction with triphenylarsine oxide with dibromotriphenylarsine unoxidized by the hydrogen peroxide adduct. No corresponding abstraction of sulfur from triphenylphosphine sulfide by niobium pentachloride appeared to occur. Preliminary experiments indicated the formation of a I:I complex. (auth)

17908 NIOBIUM(V)–TIRON COORDINATION COMPOUNDS. J. E. Land and Nancy M. Morris (Auburn Univ., Ala.). J. Less-Common Metals, 8: 266-71(Apr. 1965).

Niobium pentoxide, freshly precipitated, reacted with an alkaline solution of tiron to produce a water-soluble, yellow colored complex. By means of spectrophotometric measurements, it was established that a I:I and then a I:2 niobium to tiron ratio exists as the tiron concentration was increased from 2×10^{-3} to 8×10^{-3} M, with the niobium kept constant at 4.1×10^{-4} M. The formation constants for these species at a pH of 8.2 were determined to be 228 and 96, respectively. A solid ammonium salt of uncertain composition of the niobium–tiron complex was isolated. (auth)

17909 DETERMINATION OF THE MELTING POINT OF URANIUM DIOXIDE. H. Hausner (General Electric Co., Pleananton, Calif.). J. Nucl. Mater., 15: 179-83(1965).

Reported values for the melting point of UO_2 varied between 2400 and 2900°C during the last ten years. Most of the reported values were based on visual observation of the oxide melting. The high vaporization rate of UO_2 at temperatures near the melting point is thought to affect the accuracy of the value obtained. The melting point of UO_2 was found to be 2805 ± 15°C. This value is based on the thermal arrest observed at the melting point when a specimen of molten UO_2 was cooled under controlled conditions. (auth)

17910 ADSORPTION OF KRYPTON AND XENON ON VARIOUS ADSORBENTS. Susumu Kitani and Junichi Takada (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 51-6(Feb. 1965).

The noble gases, krypton and xenon, were adsorbed on three kinds of molecular sieves, as well as on activated charcoals, at pressures from 10^{-2} mm Hg to 1 atm at temperatures ranging from –78 to 25°C. The adsorption isotherms of krypton and xenon on two of the molecular sieves were linearly proportional to pressure, and considered to follow de Boer type isotherms. However, the isotherms for other adsorbents were found to follow the Langmuir pattern. All the isotherms are discussed in terms of functions of the heat of adsorption and surface area. The adsorbents, which show the Langmuir isotherm pattern, are considered to be efficient for practical use in removing or recovering noble gases. (auth)

17911 ANTIRADIATION COMPOUNDS. VI. METAL CHELATES AND COMPLEXES OF 2-MERCAPTOETHYLAMINE AND 2-MERCAPTOETHYLGUANIDINE. W. O. Foye and J. Mickles (Massachusetts Coll. of Pharmacy, Boston). J. Pharm. Sci., 53: 1030-3(1964).

To provide stable derivatives of 2-mercaptoethylamine (MEA) and 2-mercaptoethylguanidine (MEG) and to test one of the current hypotheses of the mechanism of radiation protection in animals (that metal binding is an important reaction in impeding cellular oxidations), metal complexes of MEA and MEG were prepared. Reaction of the trithiocarbonate zwitterions of MEA and MEG with metal salts provided straight chain (2:1) metal complexes, and direct reaction of MEA and MEG with metal salts in acid solution provided cyclic (1:1) chelates. Structures of these compounds were elaborated. One of the compounds, the Zn(II) complex of MEG has appreciable radiation protection in mice. (Excerpts Med., Sect. XXIII, 2: No. 2 (Feb. 1965))

17912 CARBON ISOTOPE EFFECTS IN THE PYROLYTIC DECOMPOSITION OF MAGNESIUM OXALATE. Peter E. Yankwich and Petros D. Zavitsanos (Univ. of Illinois, Urbanna). J. Phys. Chem., 69: 918-27(Mar. 1965). (COO-1142-57)

The ^{13}C isotope fractionation in pyrolytic decomposition of anhydrous magnesium oxalate (prepared from the dihydrate upon admixture of solutions of magnesium chloride and sodium oxalate) was studied as a function of temperature. Between 350 and 600°C the intramolecular isotope effect observed at complete decomposition fell from 0.87 to 0.62‰, thus exhibiting normal magnitude and temperature dependence (the zinc and manganous oxalate systems serving for comparison). The temperature-independent factor in the intramolecular isotopic rate constant ratio was significantly different from unity; the reaction coordinate motion made a sizable contribution to the observed isotope fractionation, a difference from the zinc and manganous oxalate pyrolyses. Ab initio calculations of the intramolecular isotope effect via the Wilson-Johnston method, employing a three-particle model Mg–O–C, agreed well with experimental results. Calculations of this type are shown to account correctly for the effect of metal atom mass on the temperature-independent factor. The partial decomposition (0 to 2 and 2 to 4%) isotope effects were measured in experiments at 350 and 373°C. Generally, the pattern of the results was similar to that observed with manganous oxalate (slight temperature dependence, large influence of degree of reaction). Unlike results obtained for zinc and manganous oxalate similarly prepared, the intramolecular isotope effects observed for sodium oxalate-precipitated magnesium oxalate were dependent upon the degree of reaction. (auth)

17913 THE REACTIVITY OF METAL IONS AND SOME OXY ANIONS TOWARD HYDRATED ELECTRONS. M. Anbar and Edwin J. Hart (Argonne National Lab., Ill.). J. Phys. Chem., 69: 973-7(Mar. 1965).

The reactivity of metal ions and their complexes with hydrated electrons was investigated by pulse radiolysis. Ligands were found to have a profound effect on the reactivity of complex ions. The sequence of efficancy of ligands to interact with e_{aq}^- and transport the electron to the central atom was: $OH^- < CN^- < NH_3 < H_2O < F^- < Cl^- < I^-$. This sequence paralleled their ability to channel an electron in outer-sphere oxidation–reduction processes. (auth)

17914 THE HEATS OF FORMATION OF ANHYDROUS EUROPIUM(II) CHLORIDE AND OF THE AQUEOUS EUROPIUM(II) ION. C. T. Stubblefield, J. L. Rutledge, and R. Phillips (Prairie View Agricultural and Mechanical Coll., Prairie View, Tex.). J. Phys. Chem., 69: 991-5(Mar. 1965).

The heats of reaction of metallic Eu and of $EuCl_2(s)$ in

hydrogen-saturated 6.00M HCl were found to be −141.0 and −21.7 kcal/mole, respectively, by adiabatic calorimetry. The reactions followed virtually oxygen-free paths and were catalyzed by platinum black. Calculations for the heats of formation of $EuCl_2$(s) and Eu(II)(aq) yielded values of −195.8 and −120.9 kcal/mole, respectively. (auth)

17915 THE THERMODYNAMIC AND PHYSICAL PROPERTIES OF BERYLLIUM COMPOUNDS. VII. ENTHALPY AND ENTROPY OF SUBLIMATION OF BERYLLIUM FLUORIDE. Jay. A. Blauer, Michael A. Greenbaum, and Milton Farber (Maremont Corp., Pasadena, Calif.). J. Phys. Chem., 69: 1069-70(Mar. 1965).

Studies were made to determine the heat of sublimation of BeF_2 by direct measurement of the vapor pressure of crystalline BeF_2 in the temperature range from 713 to 795°K. The torsion effusion technique was used. Values for the enthalpy and entropy of sublimation at 298°K were calculated to be 58.1 ± 0.7 kcal/mole and 47.8 ± 0.9 cal/(°K mole), respectively, and the corresponding enthalpy and entropy changes of fusion at the melting point (815°K) were calculated to be 1.6 ± 0.8 kcal/mole and 4.2 ± 1.1 cal/(°K mole), respectively. (M.C.G.)

17916 FORMATION OF COMPLEX COMPOUNDS BETWEEN URANYL NITRATE AND THE NITRATES OF THE FIRST GROUP ELEMENTS. THE SYSTEMS: (a) URANYL NITRATE–LITHIUM NITRATE–WATER; (b) URANYL NITRATE–SODIUM NITRATE–WATER; (c) URANYL NITRATE–POTASSIUM NITRATE–WATER; (d) URANYL NITRATE–AMMONIUM NITRATE–WATER (CONDUCTIVITY, pH, AND SPECTROPHOTOMETRY). S. S. Gupta and C. S. Pande (Lucknow Univ., India). J. Prakt. Chem., 24: 177-87(1964).

Values of resistance, conductivity, pH, % transmittance, % absorption, and optical density of the solutions were plotted against the volume of various alkali metal solutions added to a fixed volume of uranyl nitrate. As shown by the resulting diagrams, in the case of lithium nitrate there was no definite break in the regular curves, indicating that no complex compound is formed. In the case of sodium nitrate one break was observed, showing the formation of one complex compound in a 1:1 molecular ratio; whereas in the case of potassium nitrate and ammonium nitrate, two complexes are detected individually. The ratios of these two nitrates to uranyl nitrate at these points were 1:1 and 1:2, respectively. There was close similarity in the curves with respect to all the physicochemical properties investigated and, therefore, there appeared to be no question about the genuineness of the phenomenon observed. The break occurred at exact stoichiometric ratio of concentrations corresponding to the compounds described. (BBB)

17917 STUDIES ON COORDINATION COMPOUNDS OF URANYL ACETATE WITH AMINO ACIDS. THE SYSTEM: URANYL ACETATE–GLYCINE–WATER. S. S. Gupta, D. P. Garg, and S. D. Marwah (Lucknow Univ., India). J. Prakt. Chem., 24: 274-82(1964).

Conductometry, colorimetry, pH, and refractive index studies of the mixed solution of uranyl acetate and glycine revealed the existence of three complexes in 1:1, 1:2, and 1:3 molecular ratios. The compounds were crystallized and petrographic studies of the crystal were made. The following characteristics were observed in the microscopic study of the crystallization compounds of uranyl acetate-glycine: color, pale green in sections, pleochroic from colorless to pale green; form, radiating, unilateral, hexagonal; cleavage, two sets, perfect (0101) and less perfect (0001); relief, low refractive index value, always less than balsam; birefringence, moderate to very high, with interference color ranging from bright second order blue, pink, and green to very high order light pink; extinction, ranges from 0 to 30, parallel to the elongation of the crystal; figure, uniaxial, also seen was a pseudobiazial interference figure; inclusions, glycine crystals are present as inclusions, indicating that the crystallization of the glycine started first. (BBB)

17918 FORMATION OF COMPLEX COMPOUNDS BETWEEN URANYL NITRATE AND THE NITRATES OF THE FIRST GROUP ELEMENTS. III. THE SYSTEM: $CsNO_3$–$UO_2(NO_3)_2$–H_2O (CONDUCTIVITY, REFRACTIVE INDEX, COLORIMETRY, pH, VISCOSITY, AND SURFACE TENSION). S. S. Gupta and B. N. Sharga (Lucknow Univ., India). J. Prakt. Chem., 25: 318-25(1964).

Conductivity, refractive index, colorimetry, pH, viscosity, and surface tension studies of mixed solutions of uranyl nitrate and cesium nitrate showed the existence of three complex species in solution in 1:1, 1:2, and 1:3 molecular ratios, respectively $UO_2(NO_3)_2 \cdot CsNO_3$, $UO_2(NO_3)_2 \cdot 2CsNO_3$, and $UO_2(NO_3)_2 \cdot 3CsNo_3$. These compounds were detected in the solutions by the breaks in the usual curves when various parameters like conductivity, refractive index, colorimetry, pH, viscosity, and surface tension were plotted against the number of ml of cesium nitrate solution (M/100) added to a fixed volume of uranyl nitrate (M/100) solution. Thus there were three definite breaks in the resulting curves at intervals corresponding to 5, 10, and 15 ml of cesium nitrate solution. While the relation between density and concentration was a linear one, the curve for viscosity and concentration showed three kinks at exactly the same three points as for the other parameters. Surface tension, when plotted against the volume of cesium nitrate added, again gave three distinct breaks in the curve. Since there was close similarity in the curves with respect to all the physicochemical properties investigated, there seemed to be little doubt about the genuineness of the phenomenon. The breaks occurred at exact stoichiometric ratios of concentrations corresponding to the molar ratios of 1:1, 1:2, and 1:3. The complexes are presumably produced in solution according to the equation: $MNO_3 + UO_2(NO_3) \rightleftharpoons M(UO_2(NO_3)_3)$, where M = alkali metals. (BBB)

17919 AN ANALYSIS OF PHYSICAL ADSORPTION ISOTHERMS IN ULTRAHIGH-VACUUM RANGE. A. B. Huang (Georgia Inst. of Tech., Atlanta). J. Vacuum Sci. Technol., 2: 6-11(Jan.-Feb. 1965).

The detailed mechanism of physical adsorption was studied using the statistical theory of imperfect gases. The Kirkwood-Muller potential was used for the gas-solid interaction. Adsorption isotherms computed from both the classical method (high-temperature case) and the quantum-mechanical method (very low-temperature case) are given. In the case of the quantum-mechanical method of solution, the important portion of the Kirkwood-Muller potential is approximated by a linear potential, the Schrödinger equation is solved in terms of Bessel functions, and the eigenvalues of the energy are obtained. Comparisons of present results with Hobson's measurements (He on Pyrex glass at 4.2°K and N_2 on Pyrex glass from 63.3 to 90.2°K) show that the present theories are adequate in the ultrahigh-vacuum range and suggest that physical adsorption of helium on Pyrex glass at 4.2°K is completely quantized. (auth)

17920 ADSORPTION OF RADIOISOTOPES IN METALLIC OR SYNTHETIC FILMS. Pavel Svehla (Inst. of Chemistry, Brno). Jaderna Energie, 10: 452-6(Dec. 1964). (In Czech.)

The adsorption of ^{134}Cs, ^{89}Sr, ^{131}I, and ^{91}Y was determined on chrome steel, aluminum, and a synthetic coating (an alkyl paint). Approximate concentrations of the solutions studied were Cs ~ 10^{-7}, Sr ~ 10^{-9}, Y − 10^{-9}, and I ~ 10^{-11}M. With ^{134}Cs the adsorption equilibrium was not established in the same time with multiple adsorption as with simple adsorption. The pH dependence of the adsorption of ^{134}Cs and ^{89}Sr showed two maxima at pH 5 and 9 for steel and aluminum, and ^{131}I showed a maximum at pH 4 to 5. On the paint no maxima were observed as a function of pH for these ions. The mechanism of the adsorption of Cs, Sr, and I apparently depended upon the exchange of charges in the electrical double layer of metal hydroxide and this depended on the pH of the solution. The pH dependence for ^{91}Y showed a maximum of pH 7.6 to 8.6 on steel and the paint. This value was in contrast with the calculated value of pH 8.3 based on the solubility of $Y(OH)_3$. The adsorption of Y probably involved the adsorption of colloidal hydroxide particles. The adsorption of the metals depended greatly on the degree of oxidation of the surface. (TTT)

17921 KINETIC STUDY OF THE ANODIC DEPOSITION OF RADIOACTIVE SUBSTANCES. Istvan Madi. Magy. Kem. Folyoirat, 69: 150-8(1963). (In Hungarian)

Results obtained during a kinetic and static study of the anodic deposition of some radioactive elements are described. For each applied voltage an equilibrium was reached between the radioactive substance deposited on the anode and left in the solution. The system reached equilibrium as a result of competition between deposition and dissolution. The anodic deposition of the radioactive substance was determined by factors determining the time dependence of these processes. Experiments showed that when these atoms are anodically deposited, a plot of the equilibrium distribution coefficient as a function of the applied voltage passes through a maximum. The number of active centers on the surface of the platinum anode was determined for the anodic deposition of ^{144}Ce and ^{204}Tl by the isotherm method. It was found that the number of active centers as a function of the applied voltage also gave a maximum. The results showed that the hydrogen ion concentration of the electrolyte has an effect on the anodic deposition as a function of time, on the equilibrium distribution coefficient, and on the number of active centers on the surface of the anode. (auth)

17922 COVALENT RADII OF CERTAIN METAL IONS AND THE LENGTH OF THE METAL-METAL BONDS. M. J. Bennett and R. Mason (Univ. of Sheffield, Eng.). Nautre, 205: 760-2(Feb. 20, 1966).

Discussion is presented on the covalent radii of metal ions in unusual oxidation states, length of metal-metal bonds in Mo, Mn, and Co organic compounds, and the nature of the metal orbitals in $Mn_2(CO)_{10}$. It is emphasized that the derivatives of metal radii from the π-cyclopentadienyl complexes is a simplification that must not be relied on to provide accurate values; rather, it is the trend among a related class of compounds that is instructive. Also, the method of overlap analysis connot be used to obtain precise orbital coefficients until such factors as the π-bonding of the ligands, effective nuclear charge of the metal and so on are taken into account. Data are tabulated. (P.C.H.)

17923 UNIQUENESS OF THE MASS-SURFACE RELATIVE TO IRON-56. A. M. I. A. W. Durnford (Univ. of Western Ontario, London). Nature, 205: 789-90(Feb. 20, 1965).

The nature of the dependence of the mass fraction on the choice of primary standard was examined, and a criterion for the nuclide that would have the least mass fraction when employed as the primary standard was thereby established. Results of calculations showed that use of the nuclide ^{56}Fe as the primary standard would retain the conventional mass numbers; ^{56}Fe is the only primary standard nuclide that would render all mass excesses positive; in this respect it would therefore constitute a unique primary standard. (P.C.H.)

17924 ANALYSIS OF THE ABSORPTION SPECTRUM OF SOLUTIONS OF URANYL COMPOUNDS. S. de Jaegere and T. Govers (Universite, Louvain, Belg.). Nature, 205: 900-2(Feb. 27, 1965).

The absorption spectra of solutions of uranyl compounds between 20,000 and 28,000 cm^{-1} were analyzed. The compounds used were uranyl perchlorate, nitrate, and phosphate dissolved at various concentrations in water, alcohol, and acetone. $\Delta\nu$ was plotted against decreasing values of ν; $\Delta\nu$ being the difference in wave-number values for two successive absorption maxima expressed in cm^{-1} and ν being the wave-number at which these maxima appear, also in cm^{-1}. The results showed a regularity in the values of $\Delta\nu$ for different values of ν. It was found that $\Delta\nu$ equals approximately 800 cm^{-1} between 27,500 and 25,500 cm^{-1}, 650 cm^{-1} between 25,500 and 22,500 cm^{-1}, and some 750 cm^{-1} between 22,000 and 20,000 cm^{-1}. Around 25,500 and 22,500 cm^{-1} the $\Delta\nu$ values are intermediate between 650 and 800 cm^{-1}. Therefore, any decrease in $\Delta\nu$ for increasing ν values, which could be considered as significant of a convergence of bands within each one of the three regions, could be used to calculate potential energy curves for the three electronically excited states $^3\Pi_{2u}$, $^3\Pi_{1u}$, and $^3\Pi_{0u}$ of the uranyl ion. (P.C.H.)

17925 STUDIES ON THE RECOMBINER CATALYSTS TO BE USED IN THE HEAVY WATER MODERATED NUCLEAR REACTORS. Hirohito Tone (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 7: 58-64(Feb. 1965). (In Japanese)

In heavy water-moderated nuclear reactors, deuterium and oxygen are generated by the radiation decomposition of heavy water, and are released to the gas phase above the moderator in the nuclear reactor. Therefore, a recombiner is needed in nuclear reactors to prevent potential explosion hazards. A study was carried out in order to obtain the deuterium-oxygen contact reaction rate equation on the surface of almina-palladium catalysts, which are used for recombining deuterium and oxygen in the nuclear reactors. The reaction rate equation was obtained experimentally with the tubular-flow reactor in which the Al_2O_3-Pd catalysts were packed, at 60 to 150°C and 1 atm. The alumina-palladium catalysts with 0.5 wt % palladium were used. The following reaction rate equation was obtained: $r = [K_0(n^0_{D_2} - x)(2n^0_{O_2} - x)/(1 - mx)]$, where, K_0 and m are constant, x is the rate of reaction of deuterium and $n^0_{D_2}$, $n^0_{O_2}$ are the initial deuterium and oxygen concentrations. It was observed that activity of the catalysts was decreased by moisture below certain catalyst temperature. If the catalyst temperature was maintained over about 50°C, the Al_2O_3-Pd catalysts could be used without influence of moisture in the nuclear reactors for many hours. (auth)

17926 ISOTOPE EFFECT ON THE PHOTOSENSITIZED DECOMPOSITION OF AMMONIA. I. MERCURY PHOTOSENSITIZATION. Yuji Mori, Hajime Kadoi, and Ikuzo Tanaka (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi, 86: 163-8(Feb. 1965). (In Japanese)

The mercury ($Hg^*6^3P_1$ and $Hg^*6^1P_1$) photosensitized decomposition of ammonia was carried out in a circulating system at room temperature using NH_3 and ND_3 in order to determine the reaction mechanism by the isotope effect. In the case of 2537 Å, the ratio of the decomposition rates of NH_3 and ND_3, was 12 to 13 between 5 and 10 mm Hg and, below 5 mm Hg, increased with decreasing pressure (30 to 40 at 0 mm Hg). In the case of 1849 Å, the ratio was about 1 at a pressure higher than 5 mm Hg and increased with decreasing pressure (2 at 0 mm Hg). The large isotope effect, in the case of 2537 Å, can be explained by considering the quenching processes of the excited mercury atoms without decomposition of ammonia. The increase in the value at the lower pressure can be explained as the result of incomplete quenching. In the case of 1849 Å, the small value is ascribed to the very efficient singlet-singlet energy transfer process and the absence of the quenching process without decomposition of ammonia. (auth)

17927 PERTURBATION EXPANSION FOR BOND ORDERS AND THE COMMUTATOR [H,S]. S. W. MacDowell (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro), M. Giambiagi, and M. S. de Giambiagi. Nuovo Cimento (10), 35: 410-18(Jan. 16, 1965).

A perturbative expansion for Chirgwing and Coulson's and Löwdin's definitions of bond order is obtained, introducing explicitly the commutator [H,S]. Projection operator formalism is used in the development of the perturbation theory. Recurrence formulas are obtained for the corrections up to any order. The relation between both definitions is given. (auth)

17928 ON THE LUMINESCENCE OF Nd^{3+} IN $CaWO_4$. Ya. E. Kariss, A. M. Morozov, and P. P. Feofilov. Opt. Spectry. (USSR) (English Transl.), 17: 481-4(Dec. 1964). Translated from Optika i Spektroskopiya, 17: 887-92(Dec. 1964).

The absorption and luminescence spectra of single crystals of $CaWO_4$ activated by Nd^{3+} ions were investigated in the near infrared range of 300, 77, and 4.2°K. An empirical scheme for the crystalline splitting of the $^4I_{9/2-11/2}$ and $^4F_{3/2}$ levels was constructed. (auth)

17929 COMPARATIVE STUDY OF THE X-RAY AND PHOTOLUMINESCENCE OF ZnS–Cu LUMINORS. A. M.

Gurvich and M. A. Ilina. Opt. Spectry. (USSR) (English Transl.), 17: 484-7(Dec. 1964). Translated from Optika i Spektroskopiya, 17: 893-900(Dec. 1964).

A study was made of the luminescence of two types of ZnS–Cu luminors, which differed from one another in the method of preparation and in several properties, particularly the nature of the change in the spectral composition of emission in going from ultraviolet excitation at 365 and 254 mμ to excitation by x rays and cathode rays. The blue emission band, which in both cases was due to the presence of the copper, as was evidenced by measurements of the excitation spectra, showed up better for some luminors in the x-ray luminescence spectrum and for others in the photoluminescence spectrum. (auth)

17930 RELATIONSHIPS AMONG THE INFRARED BAND INTENSITIES OF A SET OF ISOTOPIC POLAR MOLECULES. L. M. Sverdlov. Opt. Spectry. (USSR) (English Transl.), 17: 515-16(Dec. 1964). Translated from Optika i Spektroskopiya, 17: 947-9(Dec. 1964).

Equations were derived for expressing relations between intensities of infrared bands in sets of isotopic polar molecules. Some numerical examples are given for hydrocyanic acid and methyl halides. (M.C.G.)

17931 CRYOGENIC PRODUCTION OF ULTRA-PURE HYDROGEN S. Shaievitz (Philips Lab., Briarcliff Manor, N. Y.). Philips Tech. Rev., 26: 27-31(1965).

An economically operating unit was developed, which is capable of producing ultra-pure hydrogen (99.995%) at a rate up to 300 m^3(STP) per hour. The process consists of two main steps: dissociation of ammonia into hydrogen and nitrogen and separation of the nitrogen from the gas mixture. This separation is mainly performed by cooling the gaseous mixture to 80°K at a pressure of 60 atm. A liquid consisting mainly of nitrogen and a vapor consisting mainly of hydrogen are then obtained. For the final purification, adsorbers are used. Two reversing adsorbers are contained in the liquid nitrogen tank and an additional pair in the product line. When one of the reversing adsorbers is in operation (at 60 atm), the other is isothermally purged at low pressure and vice versa. The other adsorbers are regenerated in the conventional manner. (auth)

17932 DYNAMIC POLARIZATION OF PROTONS IN $(La,Ce)_2Mg_3(NO_3)_{12} \cdot 24H_2O$. T. J. B. Swanenburg, N. J. Poulis, and L. J. Ancher (Kamerlingh Onnes Laboratorium, Leiden, Netherlands). Phys. Letters, 15: 12-13(Mar. 1, 1965).

Experiments were carried out to measure the nuclear polarization enhancement factor for protons in single crystals of $La_2Mg_3(NO_3)_{12} \cdot 24\ H_2O$ containing different concentrations of Ce^{3+} and of impurities, and to determine the proton polarization time as a function of the microwave power in the cavity. Results are presented and compared with values calculated from a formula obtained by Abragam and Borghini. (M.J.T.)

17933 FORMATION OF EXCITED HYDROGEN ATOMS BY CHARGE EXCHANGE IN LITHIUM. J. R. Hiskes (Univ. of California, Livermore). Phys. Letters, 15: 42-3(Mar. 1, 1965). (UCRL-12288)

Calculations on the formation of excited H atoms by charge exchange on Li-vapor targets were carried out. The Li is treated in a first approximation as hydrogen-like and in a second approximation using Hartree and Hartree-Fock wave functions. Significant differences in the population distributions of the excited atoms are found with the use of the more precise Hartree-Fock wave functions. (M.J.T.)

17934 SATELLITE LINE IN THE SPECTRUM OF Mn^{++} IN $La_2Mg_3(NO_3)_{12} \cdot 24\ H_2O$. D. Van Ormondt and T. Thalhammer (Technische Hogeschool, Delft, Netherlands). Phys. Letters, 14: 169-70(Feb. 1, 1965).

Satellite lines were observed in the spectrum of Mn^{2+} in $La_2Mg_3(NO_3)_{12} \cdot 24\ H_2O$ measured at room temperature with an X band spectrometer at 9.2 Gc, and the field dependence of the distance between the satellites and their main lines was studied from spectra recorded at 8.5 and 9.8 Gc. It was observed that the field strengths of the $Mn^{2+} \cdot 6\ H_2{}^1/_2$ complex are approximately equal when the external magnetic field is parallel to the trigonal axis and that each proton will give a similar pair of satellites at the same distance of the central line. (L.B.S.)

17935 MULTI-SPIN-AXIS STRUCTURE FOR CoO. B. van Laar (Reactor Centrum Nederland, Petten, Netherlands). Phys. Rev., 138: A584-7(Apr. 19, 1965).

New intensity data CoO in the antiferromagnetic state were obtained with a high-resolution neutron diffractometer. These improved data can be interpreted by a collinear spin structure with an angle of 27.4° between the spin axis and the c axis, as compared with the older data of Roth which gave this angle as 11.5°. Alternatively a multi-spin-axis model is proposed which explains the intensity data equally well. This model is related to the collinear model B proposed by Li and has a tetragonal spin superstructure in conformity with the tetragonal crystallographic deformation below the Néel temperature. (auth)

17936 ENERGY TRANSFER FROM COPPER AND SILVER TO RARE EARTH IN II-VI COMPOUNDS. J. D. Kingsley, J. S. Prener, and M. Aven (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev. Letters, 14: 136-8(Feb. 1, 1965).

The effect of the addition of Cu and Ag on the fluorescence of rare-earth-doped CdS, ZnSe, and ZnS was studied. It was found that rare-earth fluorescence can be excited by energy transfer from Cu and Ag in these compounds. (D.C.W.)

17937 HYPERFINE STRUCTURE OF THE 14.4-kev γ RAY OF ^{57}Fe IN HYDRATED FERRIC AMMONIUM SULFATE AS A FUNCTION OF THE MAGNETIZATION OF THE SALT. F. E. Obenshain (Oak Ridge National Lab., Tenn.), Louis D. Roberts, C. F. Coleman, D. W. Forester, and J. O. Thomson. Phys. Rev. Letters, 14: 365-9(Mar. 8, 1965). (ORNL-P-966)

The hfs spectra of the 14.4-kev gamma ray of ^{57}Fe in hydrated ferric ammonium sulfate were measured at temperatures in the liquid-helium region, both in the absence of applied magnetic fields and in applied fields large enough to produce a substantial polarization of the unpaired electron spins of the Fe^{3+} ions. The measurements were made using the Mössbauer effect. The splittings were studied as a function of the calculated magnetization of the salt. (D.C.W.)

17938 EVIDENCE FOR IMPURITY BANDS IN La-DOPED EuS. R. R. Heikes and C. W. Chen (Westinghouse Research Labs., Pittsburgh). Physics, 1: 159-62(Nov.-Dec. 1964).

Some experimental data on the electrical conductivity of La-doped EuS are presented. These and other data are discussed in terms of a model involving magnetization-dependent impurity banding. (auth)

17939 ON INVESTIGATION OF DISLOCATIONS WITH THE HELP OF NUCLEAR MAGNETIC RESONANCE. O. Kanert (Universität, Munster, Ger.). Z. Physik, 184: 92-104(1965). (In German)

The line width of the NMR signal is obtained for a statistical distribution of distances and orientations of dislocations as a function of the dislocation density. The quadrupolar part of the line width increases proportional to the root of the dislocation density in the case of first order distortion but is proportional to the dislocation density itself in the case of second order distortion. The total line width passes through a maximum within the range of first order distortion and approaches the value of the undistorted central line which arises from magnetic dipole interaction when the dislocation density becomes sufficiently large. The intensity decay of the NMR signal connected with this line width behavior is also presented. In the range of second order distortion the total line width is determined by the constant dipole interaction and the quadrupole interaction of the central line which depends on the dislocation density. Under the assumption of a Gaussian distribution for the line shape a simple expres-

sion for this width can be obtained. The calculations are checked for the case of first order distortion by measurements on the ^{23}Na and ^{35}Cl NMR signals of NaCl single crystals and for the case of second order distortion by measurements on the ^{127}I signal of KI single crystals. (auth)

17940 SPECTROSCOPIC PROPERTIES OF RARE EARTHS. Brian G. Wybourne. New York, Interscience Publishers, 1965. 243p.

The spectroscopic properties of rare earths are discussed with emphasis on the application of the results of theoretical investigations to the interpretation of experimental data. Properties of rare earth atoms and ions in the gaseous state, energy levels of rare earth atoms and ions, intensities in rare earth spectra, the Zeeman effect in rare earths, hyperfine structure and isotope shifts, and rare earth crystal spectra are discussed. (487 references) (M.C.G.)

Organic Chemistry

17941 (EUR-2114.e) PYROLYSIS STUDIES BY MASS SPECTROMETRY. J. Collin (Liège Univ. (Belgium)). 1964. 14p. (CONF-649-26). Dep.(mn).

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

The thermal decomposition of biphenyl and ethylnitrite in a quartz furnace was studied by means of a mass spectrometer. In the case of biphenyl, and contrary to previous mass spectrometry investigations, it was found that an appreciable decomposition already occurs around 450°C, in the 30 microns range of pressure, without carrier gas. The C_5H_3 and C_6H_5 free radicals were detected. Possible correlations between observed products and bond orders in biphenyl molecules are considered. As for ethylnitrite, decomposition is already very important at 200°C. Among the products detected were CH_3 radicals in small quantities, ethanol, and acetaldehyde. It is shown that a change in reaction occurs around 350°C, probably due to dehydration of ethanol and decomposition of acetaldehyde into methane and carbon monoxide. (auth)

17942 (EUR-2223.d) BESTIMMUNG DER SCHMELZWÄRME VON o- UND m-TERPHENYL. (Determination of the Latent Heat of Fusion of o- and m-Terphenyl). G. Friz, E. Boullet-Krayer, and R. Nehren (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jan. 1965. 12p. Dep.(mn).

The latent heat of fusion of o- and m-terphenyl has been determined with a simple method of technical precision. The heat per second entering into the sample has been measured by a fluxmeter and recorded. The time-integral per mass yields the latent heat of fusion. Naphthalene and diphenyl have been taken for calibration substances. Impurities of the sample substance influence very much the behavior of the fusion process. (auth)

17943 (CEA-tr-R-1776) L'ÉCHANGE ISOTOPIQUE EN TANT QUE MÉTHODE D'OBTENTION DE PRÉPARATIONS ORGANIQUES MARQUÉES AU CARBONE 14. (Isotopic Exchange as a Method of Carbon-14 Labeled Organic Preparations). V. P. Shishkov and I. I. Kameryan. Translated into French. 1962. 19p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

The possibility of obtaining ^{14}C-labeled glucose, fructose, arabinose, ribose, and galactose by reaction of sugars of ordinary isotopic composition with formaldehyde-^{14}C was established. In the exchange of glucose with formaldehyde-^{14}C, labeled glucose with an activity attaining 46% of the ^{14}C introduced was obtained. The results obtained make it possible to consider that the carbon isotopic exchange method can be used to obtain various biological and pharmaceutical preparation, labeled with ^{14}C on their functional groups. (tr-auth)

17944 (CEA-tr-R-1797) PRÉPARATION DE CERTAINS COMPOSÉS ORGANIQUES, MARQUÉS AU SOUFRE 35. (Preparation of Certain Organic Compounds Labeled with Sulfur-35). G. A. Anorova and V. Shishkov. Translated into French. [1959]. Dep.(mn); $4.60(fs), $1.52(mf) JCL.

The isotopic exchange reactions between elementary ^{35}S or the sulfur of sodium sulfide Na_2S and the sulfur of the organic compounds benzyl mercaptan, ethylene sulfide, acetylthiocholine sulfide, cysteine, cystine, and methyl thiouracil were investigated, and the preparation of specific labeled compounds by this method was compared with the results obtainable with synthetic methods. The results showed that the isotopic exchange method is technically simple but is limited by the mobility of the sulfur in the compound and the peculiarities of the compound structure. In the majority of cases, compounds with low specific activity are obtained. 4-methyl-2-thiouracil-^{35}S, 2-aminothiazole-^{35}S, acetylthiocholine-^{35}S iodide and its ternary analog, and benzylmercaptan-^{35}S could be prepared economically. (J.S.R.)

17945 ISOMERIZATION AND ISOTOPIC EXCHANGE OF 4,4′-DIMETHYLBENZHYDRYL THIOCYANATE IN ACETONITRILE. PARTITION OF ELECTRON-DEFICIENT INTERMEDIATES BETWEEN THIO- AND ISOTHIOCYANATE. Antonio Fava, Antonio Iliceta, Alberto Ceccon, and Paolo Koch (Universita, Perugia, Italy and Universita, Padua). J. Am. Chem. Soc., 87: 1045-9 (Mar. 5, 1965).

In the isomerization and exchange of 4,4′-dimethylbenzhydryl thiocyanate in acetonitrile containing $Na^{35}SCN$, only a small fraction of the isothiocyanate formed appeared to equilibrate its SCN group with the ionic thiocyanate in solution. Thus isomerization largely proceeded via an ionic path in which the organic moiety and the SCN group did not become separated. An intimate ion pair is postulated. Both isomerization and exchange reactions were subject to positive salt effect of the "normal" type. However, the exchange reaction was much more affected, indicating that it involves a more advanced stage of ionization of the substrate. By studying the relative initial rate of radioactivity intake by the two organic species, thiocyanate and isothiocyanate, it was established that, in returning to covalent state, the ionic intermediate involved in exchange partitions between thio- and isothiocyanate is the ratio of about 5 to 1. Thus, in the assumption that the intimate ion pair is a precursor of the ionic species involved in exchange, the rate of ionization exceeds the rate of isomerization by a factor of six. From the ratio of the rate of exchange to rate of ionization, the upper limit of the fraction of intimate ion pairs, which dissociate, was set to 5.4%. Thus, of 100 intimate ion pairs, about 5 undergo further ionization and 95 return to covalent state. Of the latter, about 79 return to thiocyanate and 16 to isothiocyanate. (auth)

17946 HYDROGEN BONDING IN GASEOUS MIXTURES. PART IV. INFRARED INTENSITIES. THE EFFECT OF DEUTERIUM SUBSTITUTION. J. E. Bertie and D. J. Millen (Univ. of London). J. Chem. Soc., 514-21(Jan. 1965).

The infrared spectra of complexes of deuterium chloride with various alkyl ethers in the gas phase are reported and discussed. It was concluded that the explanation suggested for the bandwidth in the spectra of hydrogen bonded complexes may be extended to deuterium-bonded complexes if it is supposed that the relative intensity of the sum and difference bands is lower in this case. A model for the bond was examined, and it is shown that this supposition of a reduction in the intensities of the combination bands is a reasonable one. The intensity in the side bands was attributed to intensity stealing from the hydrogen stretching vibration through mechanical anharmonicity. The anharmonic term in the potential function, which was responsible, was identified, and was found to be that which describes the dependence of the effective stretching force-constant of the hydrogen-chlorine bond on the hydrogen-bond length. The integrated intensities of the bands for the hydrogen and deuterium-bonded complexes were measured. The enhancement of the intensity over that for the bands of the free acids was at least fourteen-fold. (auth)

17947 THE HYDROGEN ISOTOPE EFFECT IN THE THERMAL DECOMPOSITION OF MALONIC ACID. A. T. Blades and M. G. H. Wallbridge (Research Council of Alberta, Edmonton). J. Chem. Soc., 792-4(Jan. 1965).

The thermal decomposition of molten $CH_2(CO_2H)_2$ and $CD_2(CO_2D)_2$ is reported. The rate constant kH, for decomposition of $CH_2(CO_2H)_2$ was found to be $(6.4 \pm 1.8) \times 10^{14}$ exp $[(-34500 \pm 500)/RT]$ sec^{-1}, and the observed isotope effects, K_H/K_D at 139.8 and 145.3°C were 1.09 ± 0.02 and 1.11 ± 0.01, respectively. The absence of any appreciable isotope effect in the melt confirmed that the O-H bond changes very little in character in the rate-determining step of the decomposition. (M.C.G.)

17948 DISPROPORTIONATION AND COMBINATION OF TRITIUM-LABELED ISOPROPYL RADICALS. Han Bo Yun and H. C. Moser (Kansas State Univ., Manhattan). J. Phys. Chem., 69: 1059-61(Mar. 1965).

The reactions of tritium with propane at 90, 77, and 63°K were studied to determine disproportionation or combination of isopropyl free radicals. Tritium-containing products were counted with a proportional counter or ionization chamber placed in the effluent stream from a gas chromatograph. Mechanisms of product formation are discussed. (M.C.G.)

17949 HEAT OF MIXING OF THE SYSTEM ACETONE + CHLOROFORM TEMPERATURE DEPENDENCE AND DEUTERIUM ISOTOPE EFFECT. K. W. Morcom and D. N. Travers (Univ. of Leicester, Eng.). Trans. Faraday Soc., 61: 230-4(Feb. 1965).

The heat of mixing of the system acetone + chloroform was measured over the range 0 to 70°C. The measurements at 25 and 50°C were over a wide composition range. The excess heat capacity C_p^E was found to decrease rapidly between 50 and 70°C. The heat of mixing of the system acetone + deuterochloroform was also studied at 25 and 50°C, and was found to be slightly more exothermic than the undeuterated system, in agreement with the idea that a deuterium bond is slightly stronger than a normal hydrogen bond. (auth)

Radiation Chemistry

See also BIOLOGY AND MEDICINE — Radiation Effects.

Refer also to abstracts 17664, 17667, 17741, 18271, and 18364.

17950 (ANL-6933) THE PRODUCTION OF CURIUM BY NEUTRON IRRADIATION OF Am^{241}. D. C. Stewart, R. W. Anderson, and John Milsted (Argonne National Lab., Ill.). Nov. 1964. Contract W-31-109-eng-38. 28p. Dep.; $2.00(cy), 1(mn) CFSTI.

A computer study was made of the production of ^{242}Cm. Calculated yields and compositions of curium isotope fractions are shown for intermediate to high fluxes. It is shown that better purity of ^{242}Cm results if lower fluxes are used. Curium composition data are tabulated for use in short irradiations at two low fluxes. Supplementary irradiation data (alpha activity, helium accumulation, neutron emission, heat production) are given for ^{241}Am. The production of very heavy elements from ^{241}Am is considered. (D.L.C.)

17951 (AROD-62-8) STUDY OF FREE RADICALS BY ELECTRON SPIN RESONANCE. Richard H. Schramm and George B. Cox (Army Research Office, Durham, N. C.). Aug. 1962. 10p. (AD-604992; CONF-36-4). $1.00(CFSTI).

From American Physical Society 1962 Annual Meeting, New York, Jan. 1962.

The ESR analysis of the stable free radicals formed in trifluoroacetamide by gamma irradiation is given. The structural formula for this compound is CF_3CONH_2. The effect of irradiating this compound is to break a carbon–fluoride bond to form the free radical CF_2CONH_2. The significance of the experiment lies in the measurement of the nuclear hyperfine interaction tensor for the magnetic coupling of the unpaired electron with the fluorine nuclei. (C.E.S.)

17952 (CEA-R-2604) ÉTUDE DES PHÉNOMÈNES CATALYTIQUES EN CHIMIE DES RADIATIONS. (Study of Catalytic Phenomena in Radiation Chemistry). Jean-Claude Dran (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). 1964. 67p. Dep.(mn).

Thesis submitted to Université, Paris.

Two phenomena have been studied: the action of γ rays from radio-cobalt on the adsorption and catalytic properties of ZnO and NiO in relationship with the heterogeneous oxidation of CO, and the homogeneous catalytis by OsO_4 of the oxidation of various aqueous phase solutes by the same radiation. The prior irradiation of ZnO and of NiO does not modify their catalytic activity but generally increases the adsorption energy of the gases CO and O_2. The influence of the radiations appears to be connected with the presence of traces of water on ZnO and of an excess of oxygen on NiO. Osmium tetroxide which is not degraded by irradiation in acid solution, accelerates the radiolytic oxidation of certain compounds (Te^{+4}, Pt^{+2}, As^{+3}) in the presence of oxygen, as a result of its sensitizing effect on the oxidation by H_2O_2. In the case of phosphites on the other hand, OsO_4 has a protecting action under certain conditions of acidity and may suppress entirely the chain reaction which characterizes the oxidation of this solute by γ rays. A general mechanism is proposed for these phenomena. The rate constant for the $OsO_4 + HO_2$ reaction is calculated to be 5.7×10^5 l $mole^{-1}$-sec^{-1}. (auth)

17953 (COO-1197-11) WAVE FUNCTION CALCULATIONS OF F CENTERS IN NaCl, KCl AND NaF (thesis). Juergen K. Kuebler (Kansas Univ., Lawrence Dept. of Physics and Astronomy). Dec. 1964. Contract AT(11-1)-1197. 191p. Dep.(mn); $5.00(cy), 4(mn) CFSTI.

Several approximations to the wave function of an electron trapped at a vacant Cl^- or F^- site in NaCl, KCl, or NaF are calculated. It is assumed that this trapped electron is the phenomenon giving rise to F centers. (T.F.H.)

17954 (EUR-2203.f) PREPARATION DES MOLECULES MARQUEES PAR IRRADIATION GAMMA. (Preparation of Labeled Molecules by Gamma Irradiation). R. Constant, C. Fallais, and F. Provoost (Centre d'Étude de l'Energie Nucléaire, Mol (Belgium)). Dec. 1964. 16p. Dep.(mn).

The purpose of the work is to study the marked molecules which appeared during the γ irradiation of the $^{14}CO_2-{}^{14}CH_4$ gas mixture. The influence exercised by various factors such as the CO_2/CH_4 ratio, the irradiation dose, the pressure, and the mixture with ^{14}CO on the production of the molecules, is being investigated. A start has also been made with the study of the irradiation of the CO_2-n-butane mixture. The qualitative and quantitative analyses are being carried out by means of gaseous-phase chromatography, mass spectrometry, and the ionization chamber. (auth)

17955 (NP-14815) UTILIZATION OF GAMMA RADIATION TO ENHANCE PROPERTIES OF POLYMERS AND TO INITIATE POLYMERIZATION ON MONOMERS. First Progress Report, March 23–December 15, 1964. G. Hargreaves and W. W. Howerton (Naval Air Engineering Center, Philadelphia, Pa. Aeronautical Materials Lab.). Dec. 15, 1964. 16p.

A brief summary of planned work and a synopsis of work to date with some of the problems involved are given. A literature survey and bibliography are presented. (auth)

17956 (NYO-2007-8) RADIATION CHEMISTRY PROGRESS REPORT. Gilbert J. Mains (Carnegie Inst. of Tech., Pittsburgh, Pa.). Jan. 29, 1965. Contract AT(30-1)-2007. 42p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Studies were made to elucidate the mechanism of benzene formation in the radiolysis of acetylene. Mixtures of acetylene and ^{13}C-enriched acetylene were subjected to

3-Mev electrons and mercury-photosensitization. The isotopic distribution of benzenes in the products was found to be similar for both radiolysis and photolysis and to conform closely to those predicted if only C–H bonds are ruptured. The mercury-sensitized photolysis of GeH_4 at 25°C was studied, and the variables affecting the H_2 yield were investigated in detail. The results indicate that the photolysis proceeds by rupture of a Ge–H bond, the H atoms formed are very reactive towards GeH_4, and the higher Ge hydrides are rapidly consumed in polymer formation. The products from electron radiolysis of SiH_4 were studied, and the results indicate that H_2 is produced by both molecular elimination and H atom abstraction reactions, and that the reaction between H and SiH_4 is very rapid. The mechanisms of the product formation in the gas-phase x radiolysis of $Si(CH_3)_4$ were studied in detail. (D.L.C.)

17957 (PAN-576/V) HOT PHOSPHORUS ATOM REACTIONS IN LIQUID ORGANIC MIXTURES. Andrzej Siuda (Polish Academy of Sciences, Warsaw). Inst. of Nuclear Research. Nov. 1964. 15p. (CONF-773-36).

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

The effect of the organic diluents on the yield of ^{32}P-labeled phenylphosphonic acid formed in 1 M benzene solutions of phosphorus trichloride as a result of the ^{31}P (n, gamma)^{32}P reaction has been investigated. The yield of phenylphosphonic acid decreases linearly with the increase in cyclohexane mole fraction. On the other hand, with carbon tetrachloride dilution the yields of phenylphosphonic acid are greater than one would expect from the composition of the mixtures. The results show that the reactions between the recoil phosphorus atoms and the benzene molecules resulting in phenylphosphonic acid can be affected by surrounding molecules. (auth)

17958 (PAN-577/V) REACTIONS OF TRITIUM RECOIL ATOMS IN LIQUID ORGANIC MIXTURES. Alicja Sokłowska (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Nov. 1964. 19p. (CONF-773-37)

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Studies on reactions of recoil tritium atoms in organic liquids were carried out in mixtures of cyclohexane and benzene. It was observed that the activities found in the form of tritiated benzene and cyclohexane are linearly proportional to their mole fraction in the mixture. It was concluded that the reactions of T for H substitution in cyclohexane and benzene molecules in the studied system do not depend on the composition of a mixture. (auth)

17959 (SC-TM-64-1742) SCINTILLATION PROBE TAIL-OFF: A PRELIMINARY INVESTIGATION. E. L. Jacobs (Sandia Corp., Albuquerque, N. Mex.). Dec. 1964. Contract [AT(29-1)-789]. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

In a study of low-level, slow-decay components on the trailing edge of scintillation pulses, tail-off was found in all the solid and degassed-liquid scintillators investigated. Freshly mixed, air-saturated liquids did not exhibit this slow-decay fluorescence, but some types acquired slow-decay components after being isolated from air for several weeks. Exposure to air restored the fast-decay properties of time-degraded liquids. Dissolved oxygen was assumed to be responsible for inhibiting tail-off of liquids. (auth)

17960 (TID-21520) INFRARED SPECTRA OF PLASTICS AND ELASTOMERS AFTER NUCLEAR IRRADIATION. Progress Report. W. C. Sears (Georgia Univ., Athens Dept. of Physics). Sept. 3, 1964. Contract AT(40-1)-2418. 21p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Spectra of irradiated polyethylene films during melting in the absorption cells show that oxidation has been eliminated. The evidence for loss of methyl groups by electron irradiation of polyethylenes is criticized. Electron irradiation results in high crystallinity loss compared to gamma irradiation. The trans-vinylene bands and their integrated intensities are discussed. The effects of alpha and reactor radiations on the trans-vinylene yield are discussed. Three types of neoprenes were purified, and the crystalline bands were identified. (D.L.C.)

17961 (SLAC-Trans-14) DISCOLORATION OF ALKALI METAL HALIDE CRYSTALS BY HIGH-ENERGY RADIATION. B. H. Dorendorf and H. Pick. Translated by T. Watts for Stanford Univ., Calif., from Z. Physik, 128: 166-71(1950). 13p. Dep.(mn); $1.60(fs), $0.80(mf) CFSTI.

The discoloration of alkali metal halide crystals by high-energy radiation is reported. In addition to the F band, this discoloration is also associated with the appearance of a V band, which precedes the intrinsic absorption. The properties of the V band are compared with those of the F band, and an interpretation is derived from the comparison. (auth)

17962 SOME REACTION KINETICAL PROBLEMS OF THE RADIATION THERMAL CRACKING OF HYDROCARBONS. Gabor Foeldiak and Zoltan Paal. Acta Chim. Acad. Sci. Hung., 42: 421-31(1964). (In Russian)

The radiochemical cracking of cetane by means of high-voltage electric discharge was studied. It was proved that the decomposition process that takes place in the presence of an electric field is a chain reaction only at temperatures (ϑ) over 250°C. According to thermal experiments carried out parallel, at temperatures over Θ = 320°C, the energy of the system was satisfactory not only for propagation but also for chain initiation. Consequently, at this temperature a thermal decomposition with a measurable rate takes place. The limiting temperature Θ is approximately independent of whether an electric field or radiation were applied. Under the given experimental conditions, at temperatures over 380°C, the rate of the radioinduced thermal cracking was negligible. The value of ϑ was not affected by the addition of aromatic compounds while the value of Θ increased in this case. On the use of aluminum silicate as cracking catalyst, the catalytic-thermal decomposition proved to disclose measurable rates over Θ_{cat} = 120°C even without applying any electric field. On applying relatively low ratios of catalyst to oil, each of the limiting temperatures Θ_{cat}, ϑ and Θ could be detected as well. On the basis of the disclosed regularities, the reaction rate of decomposition and the terms of limiting temperatures were expressed by mathemetical correlations. (auth)

17963 THE BEHAVIOR OF PLASTICS UNDER IRRADIATION. H. Wilski (Farbwerke Hoechst AG. vormals Meister Lucius and Bruening, Frankfurt am Main). Atomwirtschaft, 10: 70-5(Feb. 1965). (In German)

Investigations were carried out to find out how plastics may be tested for radiation stability and how the results obtained may be critically evaluated. Important parameters which serve for the comparison of irradiated and unirradiated specimens are provided by a series of mechanical properties, such as, tensile strength, modulus of elasticity, and notched impact ductility. An unambiguous criterion of radiation stability was not possible since changes corresponding to disadvantageous modifications of these properties did not result from equal dose rates or with equal proportions. For example with certain plastics tensile strength, modulus of elasticity and shear strength were maintained up to high dose rates while the elongation fell to a half of its initial value at a fraction of the same radiation loading. It was therefore necessary to specify as a measure of radiation stability that dose at which the most sensitive property attained a value of 25 or 50% of its initial value. An example of a particularly radiation-stable thermoplastic is polystyrene, which owes its resistance to the large number of benzene rings in its molecules. Results were not applicable to the effects of long term irradiation at small dose rates in air. The influence of oxygen was particularly marked in the case of polyethylene. PVC (polyvinyl chloride) showed similar reactions. Combination plates of plastics and metal powder with cadmium and boron additives, suitable for screening against neutrons and gamma radiation, are described. (auth)

17964 AN ELECTRON SPIN RESONANCE STUDY OF IRRADIATED POLYMETHYLACRYLATE. Hiroshi Yoshida, Toshiyuki Kodaira, Kozo Tsuji, Koichiro Hayashi, and Seizo Okamura (Kyoto Univ.). Bull. Chem. Soc. Japan, 37: 1531-4(Oct. 1964).

Electron spin resonance (ESR) spectra of irradiated polymethylacrylate (PMA) were studied at various temperatures. Quantitative studies of the decaying behavior of the free radicals in PMA were made above and below the glass transition temperature (3°C). At −196°C the ESR spectra had no distinct hyperfine structure. With successive warmings to 18°C, the spectra changed from a singlet with the half-height width of 36 oersted into a triplet. The separation of the triplet hyperfine components was 22 oersted. For comparison, the ESR spectra of irradiated methylacrylate and polyethylacrylate were also studied. The concentration of free radicals in PMA increased with the radiation dose. At temperatures below the glass transition point of PMA, the radical concentration decreased rapidly at the beginning of warming, but it readily attained a final value at each temperature. At the transition point, the free radicals disappeared following a 2nd order decay process. This was also true above the transition point except at the beginning of warming. It was concluded that the free radicals giving a triplet spectrum disappear through recombination caused by segmental motion in the polymer. (M.C.G.)

17965 THE RADIATION-INDUCED ADDITION OF HYDROGEN SULFIDE TO OLEFINS. Ken'ichi Sugimoto, Wataru Ando, and Shigeru Oae (Kurashiki Rayon Co., Ltd., Okayama, Japan; Radiation Center of Osaka Prefecture; and Osaka City Univ.). Bull. Chem. Soc. Japan, 38: 221-3(Feb. 1965).

The radioinduced free radical addition of hydrogen sulfide to olefins to give the corresponding thiols was studied. The addition of the thiols to olefins was found to undergo a free radical chain reaction, readily yielding the corresponding sulfides in the succeeding step. However, the thiols were found to be the only component when an excess of hydrogen sulfide was used. The reactivity of the radical chain reaction decreased with an increase in the carbon number of α-olefins. (auth)

17966 THE RADIATION-INDUCED CIS-TRANS ISOMERIZATION OF 2-BUTENES BY HYDROGEN SULFIDE. Ken'ichi Sugimoto, Wataru Ando, and Shigeru Oae (Kurashiki Rayon Co., Ltd., Okayama, Japan; Radiation Center of Osaka Prefecture; and Osaka City Univ.). Bull. Chem. Soc. Japan, 38: 224-6(Feb. 1965).

Radioinduced free radical isomerizations of 2-butenes with hydrogen sulfide at room temperature gave identical mixtures of about 72% trans- and 28% cis-butenes. The G-value of the isomerization was 20 to 50 times larger than that of the formation of the addition product. With gamma irradiation, 2-butenes in the presence of hydrogen sulfide were rapidly isomerized, even with a very small radiation dose. This ready isomerization indicated the ease of the reversibility of the first step of the sulfhydryl-radical addition reactions. (auth)

17967 THE RADIATION-INDUCED ISOMERIZATION OF 2-BUTENES. Wataru Ando, Ken'ichi Sugimoto, and Shigeru Oae (Radiation Center of Osaka Prefecture; Kurashiki Rayon Co., Ltd., Okayama, Japan; and Osaka City Univ.). Bull. Chem. Soc. Japan, 38: 226-34(Feb. 1965).

A detailed study of the radioinduced trans-cis isomerization of 2-butenes was made. The effects of halogenated compounds on 2-butene can be explained by the attack of the halogen radicals formed in irradiation, and a radical chain process can be suggested for the isomerization. The addition of hexane or cyclohexane to 2-butene in the gas phase showed a rapid isomerization of trans to cis; it is suggested that this is caused by the hydrogen atom formed in irradiation of hexane or cyclohexane. The facile isomerization of 1-butene to trans-2-butene by the presence of such hydrocarbons suggested that the hydrogen is readily exchanged with the other hydrogen of olefin, thus leading to the isomerization. Radioinduced isomerizations brought by benzene, sulfur dioxide, nitric oxide, carbon disulfide, and other molecules were also examined. The effect of benzene on the trans-cis isomerization of 2-butene was explained by production of vibrationally-excited triplet states. Results with sulfur dioxide showed that radioinduced isomerization is due not only to the formation of the first triplet state, but also to the addition to the double bond, followed by dissociation. (auth)

17968 THE RADIOLYSIS OF CRYSTALLINE OXALATOCOBALT(III) COMPLEX SALTS. Hirotoshi Sano, Noriko Matsubara, and Nobufusa Saito (Ochanomizu Univ., Tokyo and Tokyo Univ.). Bull. Chem. Soc. Japan, 38: 333-4(Feb. 1965).

The radiolysis of seven crystalline oxalatocobalt(III) complex salts is reported. The amount of cationic cobalt(II) species present in the irradiated compound was determined. It was found that the amount of cobalt(II) increased with increasing gamma doses. (M.C.G.)

17969 STUDIES OF THE CHOLINE OF FOODS. XI. γ-RADIATION DECOMPOSITION OF CHOLINE CHLORIDE IN AQUEOUS AND ALCOHOLIC SOLUTIONS. Isao Toyosawa. Bull Univ. Osaka Prefect., Ser. B, 15: 1-7(1964).

Dilute solutions (under 0.7%) of choline chloride were exposed to γ radiation. It was found that choline chloride in aqueous solution is easily decomposed and produces a large amount of trimethylamine, while choline ion in alcoholic solution has a firm resistance to the radiation decomposition. In the irradiated aqueous solution of choline chloride, mono- and dimethylamine were identified as the volatile amines other than trimethylamine by the dinitrophenyl-procedure and paper chromatography. These amines were estimated quantitatively by a colorimetric method. (P.C.H.)

17970 RADIATION CHEMISTRY OF ALKALI THIOSULFATES. R. L. Eager and D. S. Mahadevappa (Univ. of Saskatchewan, Saskatoon). Can. J. Chem., 43: 614-23(Mar. 1965).

The salts $Na_2S_2O_3$, $Na_2S_2O_3 \cdot 5H_2O$, $K_2S_2O_3 \cdot \frac{1}{2}H_2O$ were irradiated at room temperature with ^{60}Co gamma rays. When the irradiated salts were dissolved in water, sulfite and sulfate ions, H_2S gas, colloidal sulfur, and a relatively small quantity of acid were found among the irradiation products. The dependence of yields on the absorbed dose was studied. G-values of approximately unity were found. Using ^{35}S as a tracer, it was found that the inner sulfur (the central, oxygen-bonded sulfur atom of the complex) appears in the sulfite and sulfate whereas the outer sulfur (the sulfur linked only to the central sulfur and not to oxygen) appears in the H_2S and colloidal sulfur. Annealing experiments using irradiated $Na_2S_2O_3$ and $K_2S_2O_3$ showed that the yields of sulfite, sulfate, and H_2S were decreased by heating. The sodium salts were also irradiated at 77°K. The yields of sulfate and H_2S were higher for the low temperature irradiations as compared to room temperature irradiations, whereas the yields of sulfite were lower. A tentative mechanism, which partially explains the results, is proposed. (auth)

17971 RADIATION CHEMICAL FORMATION OF URANIUM PEROXIDE IN KETONE SOLUTIONS OF URANYL NITRATE. J. Teply, V. Stulik, M. Teichmanova, and J. Moravec (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 30: 1-9(Jan. 1965).

Irradiation of uranyl nitrate solutions in methyl isobutyl ketone and methylcyclohexanone saturated with water and oxygen by ^{60}Co γ rays led to the formation of an isoluble precipitate, considered to be most probably uranium peroxide $UO_4.4\,H_2O$. Its radiation yield decreased with increasing uranyl nitrate and nitric acid concentration, it increased with increasing water and oxygen concentration. Uranium peroxide was also formed from ketone solutions by direct precipitation with dilute hydrogen peroxide. In the two-phase system ketone–water with dissolved uranyl nitrate the precipitate was formed preferentially at the interface. In aqueous solutions it was formed in negligible

extent at lower concentrations than 0.005M – $UO_3(NO_3)_2$. (auth)

17972 PARAMAGNETIC RESONANCE IN GAMMA IRRADIATED SODIUM DITHIONITE. D. S. Mahadevappa (Indian Inst. of Science, Bangalore). Current Sci. (India), 33: 647-8(Nov. 5, 1964).

The ESR spectrum of sodium dithionite irradiated with ^{60}Co gamma rays was measured. The spectrum consisted of a single absorption line with a g value of 2.005. The line width was 10.4 gauss at room temperature and remained the same at the temperature of liquid nitrogen. The results support the view that the ESR spectrum is due to the SO_2^- ion. (D.C.W.)

17973 RADIOLYSIS OF CERTAIN Co(III) COMPLEXES. L. N. Neokladnova and G. A. Shagisultanova (Belorussian State Univ., USSR). Dokl. Akad. Nauk SSSR, 158: 1376-9 (Oct. 21, 1964). (In Russian)

Changes in $[Co(NH_3)_5H_2O]Cl_3$ (I) and $[Co(NH_3)_4(H_2O)_2]Cl_3$ (II) solutions resulting from gamma irradiation were determined by measuring the absorption spectrums, electrical conductivity, and pH. At doses of 5.5×10^{13} Mev, the solutions changed color from rose to yellowish brown, often with precipitation of the hydroxide. With dilution of the solutions, the radiation effect increased greatly. The increase in light absorption was especially great for compound II. In compound I there was a tendency for the absorption spectrum to return to the original form. The behavior of solutions that had stood in the dark for 30 days was similar to that of the irradiated solutions. Irradiated solutions of compound II, 0.005 M, had a high catalytic activity, 67.5 moles of H_2O_2 per mole of complex, while the nonirradiated solution had no such catalytic activity. This supported the suggested hydrolytic nature of the radiochemical decomposition of the complex. Further support was given by preparation of the compound $[(NH_3)_4Co(OH)_2Co(NH_3)_4]Cl_4$, which, not irradiated, had a strong catalytic activity and gave an absorption spectrum similar to that of compound II. The yield of the radiochemical reaction was calculated to be 42 moles/100 ev. The oxalate complex ion, $[Co(C_2O_4)_3]^{3-}$, was decomposed by a redox mechanism. (TTT)

17974 SOME FEATURES OF DECOLORATION OF ALKALI HALIDE CRYSTALS BOMBARDED BY NEUTRONS DURING ISOTHERMAL ANNEALING. B. V. Budylin and Yu. F. Kozlov. Fiz. Tverd. Tela, 6: 1573-8(1964).

Single crystals of KI, KBr, KCl, NaI, NaBr, and NaCl grown from fused salts were used. For studying isothermal annealing in single crystals, specimens in the form of parallelopipeds were produced by appropriate cleavage to give dimensions of $5 \times 5 \times 15$ mm. The specimens were irradiated in the duct of a reactor at 20°C by an integrated flux of neutrons ranging from 1.2×10^{15} to 1.2×10^{20} neutrons/cm^2. The test and control specimens were placed in ceramic crucibles having a high thermal inertia, and these were set in a crucible furnace. Specimens were extracted from the furnace and cooled at set intervals of time. The rate of temperature change in the process did not exceed 15°/min. The required observations were made on cleavage fragments of annealed samples by means of a metallographic microscope. Results show that isothermal annealing of specimens irradiated with an integrated flux exceeding 10^{18} neutrons/cm^2 leads to anomalous destruction of color centers in the zone adjacent to crystal faces. Macroscopic pores are formed throughout the whole volume of the annealed samples. The formation of these pores is accompanied by increased intensity of light scattering and by an acceleration of anomalous local decoloration. This local decoloration takes place in two stages. The first involves decrease in defect saturation in the zone next the crystal face because of microdiffusion to the boundaries. The second, accompanied by development of cloudiness in the crystal, involves the formation of an internal escape mechanism for the defects formed by the pores. These pores are due to diffusion decay of solid solutions saturated with vacancies. (OTS)

17975 RADIATIVE SYNTHESIS OF DOUBLE BOND POLYMERS. I. Tabata. Genshiryoku Kogyo, 8: No. 2, 22-6(1962). (In Japanese)

Methyl vinyl cyanogen was polymerized, in both liquid and solid form, by gamma irradiation at 40-196°C. Infrared absorption spectrums of the products from liquid-phase irradiation showed more – C = C = N– groups at high temperatures than at low. The solid-phase-irradiated material had a large number of – C = N– groups. The viscosities of acetone solutions of the polymers showed that, for equal yields, the degree of polymerization was higher when the polymerization was done in the solid phase at a temperature lower than that of the liquid. Polymers formed by irradiation below 100°C differed considerably in properties from those formed by other methods. The concentrated polymer was approximately a monocrystal. Slight heating changed its color to a clear red. Its stability to solvents and inorganic acids differed from that of polymers formed by other methods. Irradiation of vinyl cyanide mixed with ethylene polymerized only the cyanide, the ethylene acting as a sensitizer. The polymerization rate changed with changing ratio of the mixture and was minimum at a 1 : 1 ratio. With a higher concentration of vinyl cyanide the product was darker in color. Infrared spectra showed no C = N groups in polymers produced from low-concentration material, and an increasing number as the concentration increased. Radiation polymerizations of acetylene, acetophenone, alkyl cyanogen, and benzene are also described. (IIC-M.G.)

17976 ELECTRON-SPIN RESONANCE IN RADIATION CHEMISTRY. N. Tamura. Genshiryoku Kogyo, 9: No. 2, 7-15(1963). (In Japanese)

The structure of atomic groups formed in the irradiation of high-molecular material and the reaction mechanism are discussed. The hyperfine spectral lines show both isotropic interaction resulting from hyperfine conjugation and configuration of the interacting free groups and anisotropic interaction resulting from reaction between an electron and a nucleon. From the resonance spectra of irradiated and high-temperature annealed polyethylene, Teflon, polyfluoroethylene, polychlorovinyl and polypropylene, polyphenylethylene, and polymethacrylic acid, the structure of the groups formed was determined. The groups found in the various compounds are listed. The dependence of the concentration of the group on radiation intensity in a vacuum at low temperature was linear at 100 MRad for polypropylene, but polyethylene and polychlorovinyl were saturated because of the high irradiation temperature. A decrease in the groupings is explained by rearrangement. ESR studies on polymerization of polyethylene with gaseous styrene showed that the grafted polyethylene groups are of the propenyl type. Conversion to a methacrylobutyl ester was observed in the polymerization of polyethylene and other high-molecular substances. Results of irradiation of liquid hexane (135°C) with accelerator electrons showed that all spectral lines are quadruplet and triplet, which established the groups in liquid hexane. (IIC-M.G.)

17977 HEAVY WATER RADIOLYSIS IN A HIGH-POWER JRR-2 OPERATION. Kh. Tono. Genshiryoku Kogyo, 9: No. 3, 65-9(1964). (In Japanese)

In the JRR-2 recombiner, deuterium reaction was nearly complete with long catalyst (Al_2O_3 – 0.5% Pd) contact time. At 30°C, water was adsorbed on the catalyst surface, decreasing its effectiveness; at 60°C adsorption was no problem. At 5 Mw reactor operation, 70 liters of D_2 (60 g of heavy water) per hour was formed. Decomposition of D_2O may be affected by reactor power, the pressure, and heavy water temperature, electrical conductivity, pH, and dissolved oxygen. Helium goes through the recombiner at a rate of 250-300 liters/min and at the inlet contains 0.3-0.4 mole % D_2, as well as some H_2 and H_2O_2. Some D_2O_2 may accumulate in the D_2O, increasing rate of D_2O decomposition and reactor corrosion. After a time D_2O_2 reaches a saturation value, which is lower at higher temperatures. Oxygen dissolved in the heavy water also increases its decomposition rate and the reactor corrosion

rate. At 5 Mw power, the dissolved oxygen is around 2×10^{-4} g-mole/liter. The amounts of oxygen dissolved in the heavy water, D_2O_2 formed, and gaseous D_2 were measured and correlated. (IIC-M.G.)

17978 RADIOLYSIS OF ETHYLENE. II. PRIMARY FREE RADICALS AND THEIR REACTIONS. G. G. Meisels (Union Carbide Corp., Tuxedo, N. Y.). J. Am. Chem. Soc., 87: 950-7(Mar. 5, 1965).

The effects of pressure and dose rate of the radiolytic production of C_3 to C_8 hydrocarbons from ethylene were evaluated. The effects of oxygen and iodine on product distribution indicated that butenes, cyclobutane, acetylenes, and 2-hexenes do not require radicals as precursors for their formation. The major initial radical species were hydrogen atom and methyl radical while n-propyl, sec-propyl, and sec-butyl radicals were produced in small quantities by direct processes not involving radical reactions, presumably by higher order ion-molecule reactions. A quantitative kinetic treatment was developed employing the following simplifying assumptions: the steady-state concentration of all radicals is determined only by hydrogen atom and its sequent radicals; initial radical yields are constant; and all radicals add to ethylene or combine with ethyl radicals. Analysis of the data employing kinetic relationships derived in this treatment demonstrated the applicability of a free-radical mechanism for the formation of the higher, normal alkanes. Rate constants were derived for a number of reactions of methyl, ethyl, and n-butyl radicals and were in good agreement with the literature. An extension of the reaction mechanism led to a quantitative description of the dose rate and pressure dependences of the γ-initiated polymerization of ethylene at room temperature, which was in good agreement with published experimental data. (auth)

17979 A PULSE RADIOLYSIS STUDY OF PEROXY RADICAL-AROMATIC AMINE REACTIONS. A. MacLachlan (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Am. Chem. Soc., 87: 960-4(Mar. 5, 1965).

Pulse radiolysis was used to produce peroxy radicals under conditions allowing the mode and rate of their interaction with aromatic amines to be observed directly. Cyclohexyl peroxy radicals in cyclohexane formed complexes with diphenylamine (DA) and N-methylaniline, while no complex was observed with N,N′-diphenyl-p-phenylenediamine (N,N′-DPPD) under the same conditions. Deuterium isotope effects were observed and used to interpret the results. The α-ethanol peroxy radicals in ethanol formed long-lived complexes with all aromatic amines tested. Implications of these results to the basic mechanism of oxidation inhibition are discussed. (auth)

17980 SOME OBSERVATIONS ON THE CHEMICAL BEHAVIOUR OF CARRIER-FREE ANTIMONY-125. K. H. Jones and M. Kahn (Univ. of New Mexico, Albuquerque). J. Inorg. Nucl. Chem., 27: 497-502(Mar. 1965).

The preparation and stability of ^{125}Sb(III) and ^{125}Sb(V) in HCl, H_2SO_4, and $HClO_4$ were studied as well as the effect of various oxidizing and reducing agents on the oxidation states of ^{125}Sb. Oxygen and ordinary fluorescent laboratory light caused oxidation of ^{125}Sb(III). Contrary to the behavior of Sb(V) at ordinary concentrations, ^{125}Sb(V) was reduced by chloride ion in strong HCl solutions. The absorption of ^{125}Sb by Pyrex at various pH values was independent of the oxidation state of ^{125}Sb. Some radiocolloidal and coprecipitation studies are reported. (auth)

17981 RAPID PREPARATION OF CARRIER FREE I-131 FROM NEUTRON-IRRADIATED TELLURIC ACID. H. Sorantin and H. Bildstein (Oesterreichische Studiengesellschaft fur Atomenergie, GmbH, Vienna). J. Inorg. Nucl. Chem., 27: 521-6(Mar. 1965).

Carrier-free ^{131}I was prepared from neutron-irradiated telluric acid by dissolving the latter in weak hydrochloric acid and precipitating it with ethanol. The ^{131}I-containing filtrate was made absolutely tellurium-free by passing it over a column of chromatographic grade alumina. Yields of 60 to 65% were obtained. Another 20% could be eluted, also carrier-free, from the column by 0.01 to 0.1N ammonia, giving an overall yield of 80 to 85%. (auth)

17982 THE NEUTRON ACTIVATION OF CHLORATES AND PERCHLORATES AND THE PREPARATION OF $^{38}ClO_3^-$ AND $^{38}ClO_4^-$. N. K. Aras, B. Kahn, and C. D. Coryell (Massachusetts Inst. of Tech., Cambridge). J. Inorg. Nucl. Chem., 27: 527-33(Mar. 1965). (MIT-905-18)

Conditions were studied for the preparation of chlorate and perchlorate ions tagged with 37-min ^{38}Cl tracer. Neutron activation of alkali chlorates gave about 5% of the ^{38}Cl as $^{38}ClO_3^-$ and no appreciable amount as $^{38}ClO_4^-$; activation of the perchlorates gave about 14% of the ^{38}Cl as $^{38}ClO_3^-$ but only negligible amounts as $^{38}ClO_4^-$. Heat treatment of neutron-activated $NaClO_4$ or $KClO_4$ for 20 minutes at 500°C gave about 10% of the total ^{38}Cl as $^{38}ClO_4^-$. Anodic oxidation of chloride and oxidation by argentic ion were not promising for the production of tagged perchlorate ion but the latter process can be used to prepare tagged chlorate. Separation and identification of chloride, chlorate, and perchlorate were accomplished by selective elution by nitrate ion from an anion-exchanger column (order of appearance, Cl^-, ClO_3^-, and ClO_4^-). Procedures are given for the preparation of $^{38}ClO_3^-$ free of appreciable bulk chlorate or other oxidation states of chlorine, and for milligram amounts of perchlorate tagged with $^{38}ClO_4^-$, free of other oxidation states of chlorine. (auth)

17983 ALPHA RADIATION EFFECTS ON CONCENTRATED LiCl SOLUTIONS CONTAINING HCl, AND THE USE OF METHANOL AS AN INHIBITOR OF ACID RADIOLYSIS. R. D. Baybarz (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 27: 725-30(Mar. 1965). (ORNL-P-154)

The principal effect of alpha radiation on a 10M LiCl-0.02M HCl solution is the loss of approximately 0.1 mole of HCl per day for each liter of solution exposed to 10 w of radioactivity. Methanol completely inhibited the loss of acid due to radiolysis and nearly stopped the production of radiolytic gases. (auth)

17984 A METHOD OF PREPARING OF COBALT-58. Kiko Akatsu and Tomitaro Ishimori (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 68-71(Feb. 1965).

Carrier-free ^{58}Co produced through the neutron (n,p) reaction, is usually prepared by ion exchange, but graded multistage solvent extraction methods were successfully applied to the separation of ^{58}Co from nickel. Nickel sponge of high purity was irradiated for 15 hr in the JRR-1 reactor at Tokai. A dilute hydrochloric acid solution of about 0.2mC of ^{58}Co was obtained from 1 g of nickel sponge by this method. The radiochemical purity was determined by means of γ spectrometry and decay curve measurement. (auth)

17985 DISLOCATION BEHAVIOR IN GAMMA-IRRADIATED NaCl. Toichi Okada, Koji Shibata, and Tokuo Suita (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 2: 77-8(Feb. 1965).

An experimental study was made of gamma-irradiated NaCl using Stablein's technique. It is shown that the dose dependence of dislocation nucleation and driving stresses can be obtained separately through three-point bending tests. A schematic diagram of the test procedure is shown. Both nucleation and motion stress were found to increase with increasing gamma dosage. (M.C.G.)

17986 γ-RADIOLYSIS OF LIQUID CYCLOPENTANONE. W. W. Bristowe, M. Katayama, and C. N. Trumbore (Univ. of Delaware, Newark). J. Phys. Chem., 69: 807-15(Mar. 1965).

The major primary products from the γ-radiolysis of liquid cyclopentanone and their initial G values are as follows: H_2, 0.68 ± 0.02; CO, 0.8 ± 0.1; ethylene, 0.85 ± 0.04; cyclobutane, 0.11 ± 0.01; 4-pentenal, 0.74 ± 0.05; cyclopentanol, 0.81 ± 0.05; 2-cyclopentanone, 0.21 ± 0.02; dimer, 0.23 ± 0.02; and total polymer, 4.4 ± 0.5 (based on cyclopentanone). Minor primary products are 1-butene, n-butane and propylene (all with G values < 0.1). The effects of added

oxygen, iodine, and DPPH are reported. The isotopic hydrogen and ethylene yields from irradiated 2,2,5,5-cyclopentanone-d_4 are discussed. Possible mechanisms for the formation of the products are also discussed. (auth)

17987 RADIOLYSIS OF ETHYLENE. I. YIELD OF HYDROGEN ATOMS AND FORMATION OF SATURATED HYDROCARBONS. G. G. Meisels and T. J. Sworski (Union Carbide Corp., Research Center, Tuxedo, N. Y.). J. Phys. Chem., 69: 815-21(Mar. 1965).

The yield of ethyl radicals in the radiolysis of ethylene was estimated as 6.7 ± 0.4 radicals/100 ev by attributing the formation of ethane, propane, and n-butane solely to reactions of methyl and ethyl radicals. A yield of 6.8 ± 1.9 hydrogen atoms/100 ev was determined by use of the hydrogen atom exchange reaction with deuterium. It appeared that all ethyl radicals had hydrogen atoms as precursors and that deuterium did not affect hydrogen atom formation from ethylene. A marked enhancement of alkane yields by addition of deuterium to ethylene was attributed to a yield of 15.8 ± 0.5 deuterium atoms/100 ev absorbed in deuterium. The occurrence of either deuteron or charge transfer suggested that the yield of deuterium atoms in pure deuterium may be as high as 25 atoms/100 ev. (auth)

17988 A COMPARISON OF FAST NEUTRON AND γ-IRRADIATION OF POLYSTYRENE. I. CROSS-LINKING RATES. W. W. Parkinson (Oak Ridge National Lab., Tenn.), C. D. Bopp, D. Binder, and J. E. White. J. Phys. Chem., 69: 828-33(Mar. 1965).

Linear energy transfer (LET) effects in polymers provide an indication of the reaction mechanisms involved, as well as a basis for the prediction of property changes in a radiation field. Polystyrene specimens irradiated in γ sources and in a nuclear reactor were compared by solution viscosity, gel content, and solvent-swelling measurements. The cross-linking rate was two- to threefold higher for the reactor by all three methods. For fast neutrons (LET ~3 ev/Å.), G(cl) = 0.096 ± 0.015; for ^{60}Co γ radiation (LET ~ 0.02 ev/Å.), G(cl) = 0.034 ± 0.002. The ratio of scission to formation of cross-linked units was 0.14 for both cases. It was concluded that the increased yields of cross links at high LET can be accounted for by enhancement of second-order processes in overlapping spurs at the expense of competing first-order reactions. Several reaction mechanisms can meet these general requirements. (auth)

17989 KINETICS OF THE γ-RAY-INDUCED DECOMPOSITION OF CHLOROFORM. Horst R. Werner and Richard F. Firestone (Western Reserve Univ., Cleveland and Ohio State Univ., Columbus). J. Phys. Chem., 69: 840-9 (Mar. 1965).

Some effects of temperature, dose rate, and scavenger additives in the radiolysis of air-free liquid $CHCl_3$ were interpreted by means of a free-radical mechanism. The primary free radicals were found to be CHCl2. (G = 5.6 radicals/100 ev), Cl atoms (G = 5.4 atoms/100 ev), CCl_2 (G = 0.4 radical/100 ev), CCl_3. (G = 0.25 radical/100 ev), and H atoms (G = 0.2 atom/100 ev). Additional CCl_3 radicals were formed by reactions of $CHCl_2$ radicals, Cl atoms, and H atoms with $CHCl_3$, and the total yield of CCl_3 radicals exceeded G($CHCl_2$.) above −30°C. A relatively broad and diffuse spatial distribution of primary radicals was proposed for consistency with the onset of dose rate effects at low dose rates, a low spur radical yield, and the high probability that the fate of virtually all electrons is dissociative electron attachment in irradiated $CHCl_3$. Effects of temperature in the radiolysis of solid $CHCl_3$ are also reported and discussed briefly. (auth)

17990 THE RADIOLYSIS OF PROPANE AT EXTREMELY LOW CONVERSIONS. L. W. Sieck, N. K. Blocker, and J. H. Futrell (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Phys. Chem., 69: 888-92(Mar. 1965).

The gas-phase radiolysis of propane was investigated at extremely low conversions in order to determine initial G values. Yields of unsaturated products were found to be significantly higher than those obtained in the presence of added scavengers, and the differences could be correlated with radical-disproportionation reactions. Dose dependence is discussed and possible explanations for the variations in yield are offered. No detailed mechanism is advanced, but the quantitative yield data upon which the mechanism must rest are presented. (auth)

17991 RARE-GAS-SENSITIZED RADIOLYSIS OF ACETYLENE. J. H. Futrell and L. W. Sieck (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Phys. Chem., 69: 892-900(Mar. 1965).

The gas-phase radiolysis of acetylene was investigated in the presence and absence of various sensitizers at various dose rates. The polymerization reactions were correlated with high-pressure, mass spectrometric studies of mixtures with rare gases, with the conclusion that the precursors for polymer propagation do not depend upon charge exchange (ionization of acetylene). A quantitative investigation of benzene production and sensitization indicated that neon is unique among the noble gases in that it alone enhances the formation. The initial interaction, $Ne^+ + C_2H_2 \rightarrow C_2H^+ + H + Ne$, observed mass spectrometrically is considered responsible. Various photolysis and radiolysis experiments involving argon–deuterium–acetylene and deuterium–acetylene mixtures defined the mechanism for the increase in $G(C_6H_6)$ observed. (auth)

17992 REACTION OF TRITIUM ATOMS WITH FILMS OF SOLID ETHYLENE. DISPROPORTIONATION AND COMBINATION OF ETHYL RADICALS AT 63°K. K. W. Watkins and H. C. Moser (Kansas State Univ., Manhattan). J. Phys. Chem., 69: 1040-4(Mar. 1965).

Films of solid ethylene at 63°K were bombarded with tritium atoms. Products (ethylene, ethane, and butane) of disproportionation and combination reactions of ethyl radicals were observed. Conditions were selected under which the only apparent reactions of ethyl radicals were disproportionation and combination. Under these conditions, no contribution from tritium atom addition to ethyl or product ethylene was evident. A disproportionation to combination ratio (k_d/k_c) of 0.77 ± 0.03 was observed for $C_2H_4T + C_2H_4T$, and a ratio of 0.83 ± 0.04 was observed for $C_2H_4T + C_2H_5$. Two methods of calculating the tritium isotope effect in the disproportionation of ethyl radicals gave k_H/k_T = 1.7 ± 0.7 and k_H/k_T = 2.3 ± 0.5. These small primary kinetic isotope effects were consistent with the mechanism discussed by Bradley and Rabinovitch, which involves a "loose" transition state for disproportionation in which little or no binding occurs. (auth)

17993 EFFECT OF DENSITY ON THE RADIOLYSIS OF ETHANE. Catherine M. Wodetzki, P. A. McCusker, and D. B. Peterson (Univ. of Notre Dame, Ind.). J. Phys. Chem., 69: 1045-9(Mar. 1965).

Hydrogen and butane were the products of ^{60}Co γ-radiolysis of ethane most significantly affected by variation of density in the range 0.001 (atmospheric pressure) to 0.30 g/cm^3. $G(H_2)$ decreased from 8.3 at the low end of this density range to a plateau value of 6.6 at about 0.25 g/cm^3. $G(n\text{-}C_4H_{10})$ increased comparatively rapidly from 2.5 at 0.001 g/cm^3 to a plateau value of 3.8 at 0.075 g/cm^3. From studies of the effect of density on γ-radiolysis of ethane and of a 1:1 mixture of ethane and ethane-d_6 in the absence and in the presence of ethylene, it was concluded that there are at least three modes of hydrogen formation. Two of these, abstraction by thermal hydrogen atoms and molecular detachment, decreased in importance with increasing density; the third, a bimolecular reaction uninhibited by ethylene, increased with increasing density. The bimolecular reaction may be either an ion-molecule reaction or an abstraction by a hot hydrogen atom. Increase in $G(n\text{-}C_4H_{10})$ with increasing density was attributed to increased production of ethyl radicals, combination of which was almost exclusively responsible for butane production at all densities. It was concluded that these effects are primarily a consequence of decreased ion fragmentation and increased parent-ion recapture at high gas densities. (auth)

17994 EFFECT OF ADDITIVES IN RADIOLYSIS OF ETHANE AT HIGH DENSITIES. Catherine M. Wodetzki,

P. A. McCusker, and D. B. Peterson (Univ. of Notre Dame, Ind.). J. Phys. Chem., 69: 1056-9(Mar. 1965).

The effects of ethylene, propylene, and nitric oxide on the γ-radiolysis of gaseous ethane were investigated in the density range from 0.001 to 0.30 g/cm^3. It was concluded that ethylene functions solely as a hydrogen atom scavenger in the density range from 0.001 to 0.075 g/cm^3. A value was calculated for G(propyl), and it was determined that it exceeds G(ethyl). With additions of nitric oxide, nitrogen was produced in very large yields at high densities, suggesting a chain reaction. (M.C.G.)

17995 RADIATION YIELDS OF CARBON MONOXIDE AND DIOXIDE FOR SOME AROMATIC CARBONYL COMPOUNDS. A. A. Miller (General Electric Research Lab., Schenectady, N. Y.). J. Phys. Chem., 69: 1077-9(Mar. 1965).

Measurements were made of carbon monoxide and carbon dioxide yields and ratios in the radiolysis of selected carbonyl compounds. Samples were irradiated with 1.5-Mev electrons and the evolved gas was analyzed for H_2, CO, CO_2, and CH_4. In both the acetate and benzoate series, the phenyl and benzyl esters gave higher G values than the methyl esters. When the carbonyl group was adjacent to and conjugated with the aromatic ring, the stability against decarboxylation was increased. However, when both groups adjacent to the carbonyl were phenoxy and/or benzyl, extremely high values of G resulted. (M.C.G.)

17996 RADIOLYSIS OF FROZEN SOLUTIONS. II. SODIUM NITRITE ICES. Larry Kevan (Univ. of Chicago). J. Phys. Chem., 69: 1080-1(Mar. 1965). (COO-1365-4)

Cylindrical ice samples of sodium nitrites were irradiated at 77°K by ^{60}Co gamma rays and were subsequently examined by electron spin resonance. The initial electron spin resonance spectrum at 77°K was a composite of the hydroxyl radical spectrum and that due to NO_2. The ice sample was then warmed at 145°K over a 3-min period and re-examined at 77°K. After this treatment the hydroxyl radical spectrum decayed, while the NO_2 spectrum remained unchanged. (M.C.G.)

17997 ON ELECTRON TRAPPING IN POLYCRYSTALLINE AND IN GLASSY ALKALINE ICES. Larry Kevan (Univ. of Chicago). J. Phys. Chem., 69: 1081-2(Mar. 1965). (COO-1365-5)

The effects of glassy and polycrystalline solid phases on the trapped electron yield in alkaline ices are discussed. Irradiations on the frozen KOH and NaOH solutions were carried out with ^{60}Co gamma rays at 77°K for a total dose of 0.30 Mrad. The trapped electron yields were determined by electron spin resonance as a function of hydroxide. The trapped electron yield increased linearly with hydroxide concentration and showed no discontinuities in either of the polycrystalline-glassy transition regions. Results indicated that the efficiency of electron trapping in irradiated alkaline ices is independent of the nature of the frozen solution. (M.C.G.)

17998 PREPARATION AND CHARACTERIZATION OF SOME CELLULOSE GRAFT COPOLYMERS. PART III. THE ROLE OF CONCURRENT DEGRADATION DURING RADIATION GRAFTING. J. D. Wellons and V. Stannett (Research Triangle Inst., Durham, N. C.). J. Polymer Sci. Pt. A, 3: 847-57(Mar. 1965).

The radioinduced degradation of cellulose acetate was studied both in the dry state and in solution. The rate of degradation was greater in the solid state and was unaffected by oxygen. Conjugated solvents such as pyridine, toluene, and α-methylstyrene were shown to exert considerable protection against the radioinduced degradation of cellulose acetate when in solution or as swollen films. α-Methylstyrene was used as a model for styrene to study the amount of degradation accompanying the grafting process. Matching experiments were carried out by using both the mutual and the preirradiation methods of grafting. Considerably greater chain cleavage was found to accompany the grafting in the preirradiation case. With both methods the number of chain cleavages was measured when α-methylstyrene was present in the grafting solution and the number of grafted side chains when styrene was used. It was found that at least twice as many grafted chains as cleavages occur with the mutual technique, but in the case of preirradiation the number of cleavages is comparable to the number of grafted chains. The G (grafted chain) value for cellulose acetate with styrene was determined and was about 1.1 in all cases. The G (chain cleavage) values varied, however, from 0.2 to 1.3, approximately. The proportion of grafted chains attached to the ester groups was determined by extraction with benzene after cold alkaline hydrolysis. About half of the grafts were found to be attached in each case, including the preirradiation product. In general, at least 50% of the graft copolymers were side-chain grafts. (auth)

17999 RADIATION-INDUCED GRAFT COPOLYMERIZATION. CO-GRAFT-POLYMERIZATION OF MONOMER MIXTURES ON POLYPROPYLENE FIBERS. Masao Umezawa (Asahi Chemical Industries Co., Ltd., Japan) and Kozo Hirota. Kobunshi Kagaku, 21: 352-7(June 1964). (In Japanese)

Graft polymerization of monomer mixtures on polypropylene fibers pre-irradiated in air with a 2-Mev Van de Graaff accelerator was investigated. In the case of monomer mixtures of styrene and maleic anhydride a high degree of grafting was observed. It was found that the graft polymerization was co-polymerization of styrene and maleic anhydride on polypropylene. (auth)

18000 RADIATION-INDUCED COPOLYMERIZATION AT LOW TEMPERATURE IN THE PRESENCE OF γ-ALUMINA. Takahisa Yamagiwa (Okaya Engineering High School, Japan) and Koichiro Hayashi. Kobunshi Kagaku, 21: 421-5(July 1964). (In Japanese)

Radiation-induced copolymerization of styrene and methylmethacrylate in the presence of γ-alumina was carried out at low temperature. The influence of calcinating temperature of γ-alumina on copolymerization reaction was investigated. From the composition of copolymer obtained, it was found that a radical mechanism took place at 30°C and 0°C, but an anionic one at −78°C. In addition, in the case of γ-alumina calcinated at a temperature higher than 900°C, copolymerization was not observed because of transformation to α-alumina. Silica oxide, zinc oxide, and nickel oxide were not effective in this system. It was supposed the absorption of monomer on the surface of γ-alumina played an important role. (auth)

18001 GAMMA-RAY INDUCED POPCORN POLYMERIZATION. Tsutomu Naruse and Zen-ichiro Kuri (Nagoya Univ., Japan). Kobunshi Kagaku, 21: 431-6(July 1964). (In Japanese)

It was found that popcorn polymer was produced in aqueous acrylamide solution under the irradiation of gamma rays and that the growth of popcorn seeds in various monomers was also increased by the irradiation. A seed in a mixture of two kinds of monomer grew a popcorn copolymer. The popcorn obtained had always some characteristic infrared absorption spectra at 1730, 1650, and 750 cm^{-1}, being independent of the polymer component, and these spectra could not be seen in the general corresponding homopolymers. ESR spectra of the irradiated popcorn were also quite different from those of the corresponding homopolymers. (auth)

18002 RADIATION-INDUCED COPOLYMERIZATION OF TETRAFLUOROETHYLENE WITH VINYLCHLORIDE AT LOW TEMPERATURE. Yoneho Tabata and Kumao Hamanoue (Tokyo Univ.). Kogyo Kagaku Zasshi, 67: 482-4(Mar. 1964). (In Japanese)

Radiation-induced copolymerization of tetrafluoroethylene with vinylchloride was investigated at −78°C. It was observed that the polymerization is preceded by an induction period and inhibited by radical inhibitors such as DPPH and p-benzoquinone. The initial rate of copolymerization is proportional to the dose rate. The monomer reactivity ratios in the copolymerization were determined to be $r_1(c_2H_3cl) = 7.75$, $r_2(c_2F_4) = 0.03$. Although the polymerization rate of tetrafluoroethylene is much greater than that

of vinylchloride, the copolymerization rate is retarded by tetrafluoroethylene under the same condition. It was concluded that the copolymerization proceeded by a radical mechanism. The energy transfer to vinylchloride from tetrafluoroethylene during irradiation is considered to play an important role for the copolymerization, and so the reaction would be initiated mainly from vinylchloride radicals. The copolymer is insoluble in tetrahydrofuran, cyclohexanone, and dimethylformamide. The melting point of copolymer obtained is higher than that of polyvinylchloride. (auth)

18003 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF 3-HALOGENOMETHYL-3-ETHYLOXETANE. I. SOLID STATE POLYMERIZATION OF 3-CHLOROMETHYL-3-ETHYLOXETANE AND 3-FLUOROMETHYL-3-ETHYLOXETANE. Masatoshi Miura and Toshiyuki Aoyagi (Hitachi Ltd., Tokyo). Kogyo Kagaku Zasshi, 67: 485-90(Mar. 1964). (In Japanese)

Chlorine and fluorine derivatives of 3-halogenomethyl-3-ethyloxetane can be polymerized by γ rays only in the solid state. Polymerization behavior of those compounds depends upon the monomer crystal states. Large crystals on slow cooling treatment polymerize more rapidly and their polymers have higher molecular weight. The polymerization rate and the molecular weight of the polymer decrease with the yield of polymerization. In the chlorine derivative the existence of an induction period and an increase of molecular weight in the initial polymerization period are observed. These can be explained by long chain life time in the polymerization. The polymerization rate of the fluorine derivative is so slow that chain life time does not affect polymerization behavior. At temperatures such as -80°C, the polymerization of the chlorine derivative cannot be observed. When the irradiated crystal is warmed, polymerization occurs rapidly. The molecular weight of polymer obtained by the post-polymerization decreases with increasing pre-irradiation dose, but polymer yield is not affected practically by dose above 10^5 R. (auth)

18004 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF 3-HALOGENOMETHYL-3-ETHYLOXETANE. II. SOLID STATE COPOLYMERIZATION OF 3-CHLOROMETHYL-3-ETHYLOXETANE AND 3-FLUOROMETHYL-3-ETHYLOXETANE. Masatoshi Miura and Takako Hirai (Hitachi Ltd., Tokyo). Kogyo Kagaku Zasshi, 67: 490-2(Mar. 1964). (In Japanese)

Binary system solid state polymerization of 3-chloromethyl-3-ethyloxetane and 3-fluoromethyl-3-ethyloxetane by γ rays was investigated. From studies of phase diagrams, it is concluded that a mixture of these two ring compounds crystallizes to a solid solution. The solid solution polymerizes to copolymer having the same composition as the monomer mixture over all ranges of monomer composition. The copolymer obtained has high crystallinity and a sharp melting point. From observations of x-ray-diffraction patterns, it appears that crystal structure of the copolymer is similar to that of polymer obtained from homopolymerization of the respective components. (auth)

18005 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF 3-HALOGENOMETHYL-3-ETHYLOXETANE. III. SOLID STATE COPOLYMERIZATION OF 3-CHLOROMETHYL-3-ETHYLOXETANE AND 3,3-Bis (CHLOROMETHYL) OXETANE. Masatoshi Miura and Takao Hirai (Hitachi Ltd., Tokyo). Kogyo Kagaku Zasshi, 67: 492-6(Mar. 1964). (In Japanese)

Gamma-ray-induced solid state copolymerization of 3-chloromethyl-3-ethyloxetane and 3,3-bis(chloromethyl) oxetane was investigated. Mixtures of these two compounds crystallize to a solid solution. Polymerization behaviors of these solid solutions are similar to those of the single components. In a relationship between conversion and irradiation temperature, the conversion reaches a maximum at about 10-20°C below the melting point of the solid solution. The copolymer obtained by γ irradiation of the solid solution has the same composition as the monomer mixture, but the copolymer obtained by BF_3 has a different composition. Furthermore, from an investigation of the fractionation of the copolymer it is found that the composition distribution of the polymer depends upon the crystalline state of the monomer mixture, and the width of the distribution is narrower in the copolymer from small crystals prepared by rapid cooling than in the copolymer from large crystals. (auth)

18006 RADIATION-INDUCED POLYMERIZATION OF VINYLTRIETHOXYSILANE. Yoneho Tabata and Harutaka Kimura (Tokyo Univ.). Kogyo Kagaku Zasshi, 67: 620-2(Apr. 1964). (In Japanese)

Radiation-induced polymerization of vinyltriethoxysilane was carried out. In the liquid state polymerization, crosslinked polymers were obtained. These polymers were not soluble in the usual solvents (benzene, methanol, toluene etc.). It was suggested from the infrared spectra of the polymers that the polymerization had not proceeded by the vinyl group, probably due to the steric hindrance of the ethoxysilane. Hydrogen atoms and methyl and ethyl radicals would be formed by irradiation. These free radicals could initiate the polymerization. Activation energy in the liquid state was 0.5 kcal/mole. (auth)

18007 RADIATION-INDUCED CROSSLINKING OF CIS- AND TRANS-POLYBUTADIENES IN CARBON TETRACHLORIDE SOLUTION. Yoneho Tabata and Kumao Hamanoue (Tokyo Univ.). Kogyo Kagaku Zasshi, 67: 622-5(Apr. 1964). (In Japanese)

Cis- and trans-polybutadienes were irradiated by γ rays in carbon tetrachloride solution. It was found that the polymers are easily crosslinked by the irradiation of the solution, and the crosslinking G-value of cis-polymer is much higher than that of trans-polymer, probably depending on stereo-regularity of the polymer. It was concluded that the crosslinking efficiency is profoundly affected by the mobility of the polymer segments in the solution. The optimum concentration for crosslinking was in the region of $0.5 \sim 1.0\%$, and the polymer could be completely crosslinked with doses of $10^4 \sim 10^5$ rads. The isomerization, addition of the solvent to the polymer, and formation of double bonds by the irradiation were not observed. (auth)

18008 PHOTOSENSITIVITY OF SINGLE CRYSTAL Sb_2S_3 TO X-RAYS. A. Sirvaitis and B. Aleksejunas (Vilnius State Univ., USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstrosios Mokyklos, 4: 551-7(1964). (In Russian)

The dependence of photosensitivity of single crystals Sb_2S_3 for x rays on pressure of sulphur vapor, during the growth of the crystals was investigated. The voltage of the x-ray tube was 80, 138 and 183 kv. When the pressure of the sulphur vapor rises, the photosensitivity of Sb_2S_3 increases, and it intensively increases, in the interval 0.10 to 1.95 torr. When the pressure is 12 to 395 torr, the photosensitivity does not change. The energy ϵ^* used up for one carrier passed through a single crystal was calculated. When the effective wave length $\lambda_{ef} = 0.45$ Å, $\epsilon^* = 1$ to 4 ev and when $\lambda_{ef} = 0.15$ Å, $\epsilon^* = (6$ to $18)$ ev. Also the current vs voltage, current vs x-ray dose characteristics, inertia of photo-current, and stability of photosensitivity were investigated. (auth)

18009 RADIATION CHEMISTRY AND CHEMICAL INDUSTRY. Istvan Kiss and Magda Roder. Magy. Kem. Lapja, 19: 400-8(Aug. 1964). (In Hungarian)

A survey was made of the prospective uses of nuclear reactors as radiation sources and of recent results in radiation chemistry, which seemed important in view of their potential industrial application. Various facilities, including chemo-nuclear type reactors exploiting fission product energies, devices for the utilization of neutron and γ radiations from reactors or γ radiation from fuel elements, are described. Possible industrial uses of radiochemical procedures for chlorination, sulfonation, sulfochlorination of organics, production of hydrocarbons with fluorine or other halogen contents, and processing of refinery products are discussed. (auth)

18010 THE CHEMISTRY OF RUBIDIUM AND ITS RADIOISOTOPES PRODUCED IN NUCLEAR REACTORS. Laszlo Szirtes. Magy. Kem. Lapja, 19: 424-7(Aug. 1964). (In Hungarian)

A review of literature data on rubidium is given. The occurrence, preparation, and the physical and chemical properties of the element and its compounds are summarized. Based on literature data the production of radioactive ^{86}Rb and ^{88}Rb in the WWRS reactor and the use of these in different fields of medicine, industry, and agronomy are considered. (auth)

18011 SHORT-LIVED RADICALS IN IRRADIATED GLYCINE. J. A. Simmons (Hammersmith Hospital, London). Nature, 205: 697(Feb. 13, 1965).

Dry glycine was irradiated with 50 MRads and afterwards the sample tube was connected to a mass spectrometer tuned to mass number 2, and the vacuum seal opened. A large positive reading was obtained, from which it was concluded that about 3×10^{-7} g, corresponding to about 10^{17} molecules, had been present. A check with unirradiated glycine was completely negative. It was thus confirmed that hydrogen is a product of irradiated glycine, and accordingly it was concluded that atomic hydrogen is the reactive, short-lived radical previously postulated to account for the shape of the yield-dose curves for stable radicals. (P.C.H.)

18012 RADIOLYSIS OF CYSTEINE AND BISCYSTEINO-COBALTATE(III) IN AQUEOUS SOLUTION BY ^{60}Co γ-RAYS. Niro Matsuura (Tokyo Univ.) and Kazuko Muroshima. Nippon Kagaku Zasshi, 85: 268-75(Apr. 1964). (In Japanese)

The yields of the radiation-induced degradation of cysteine and biscysteino-cobaltate(III) were observed to be strongly dependent upon their concentrations. From the intercept of the graphs of 1/G plotted against 1/C, the extrapolated yields of degradation at an extremely high solute concentration are obtained, and these values are balanced stoichiometrically with the yields of decomposed solute and the radicals from solvent water. The values are $G^{O_2}_{CySH} = 10.5 \pm 0.5$, $G^{N_2}_{CySH} = 7.5 \pm 1.0$ for cysteine and $G^{O_2}_{Co(CyS)_2} = 12.5 \pm 0.5$, $N^{N_2}_{Co(CyS)_2} = 13 \pm 1$ for biscysteino-cobaltate(III) in the presence and absence of oxygen. These yields are too high as compared with the known primary radical yields of radiolysis of water. In order to interpret these results in accordance with the radical diffusion hypothesis, such a redox reaction has to be assumed that one radical decomposes two solute molecules. Chain mechanism cannot be involved in the interpretation because our experiments revealed that the chain oxidation of cysteine occurred in the presence of Fe^{2+} with G–CySH as large as 100. It would thus be conceivable that the contribution of an excited water molecule or excess energy transferred by radical recombination is present, which renders a disproportionation without any redox reaction. (auth)

18013 DEGRADED PRODUCTS AND REDUCING POWER OF THE GLUCOSE IRRADIATED BY γ-RAYS. Takasuke Mori, Chie Miyake, and Tadao Sano (Osaka Univ.). Nippon Kagaku Zasshi, 86: 243-6(Feb. 1965). (In Japanese)

Both D-glucose powder and a 0.5 mol/l solution of D-glucose were irradiated by γ rays from ^{60}Co. In the range of dose rate from 3.3×10^3 to 2.4×10^6 γ/hr and total doses from 2.28×10^7 to 3.01×10^8 γ. By means of paper chromatography, glucuronic acid, gluconolactone, gluconic acid, arabinose, erythrose, dihydroxyacetone, glyoxal, etc. were identified as the degraded products. The reducing power of the irradiated glucose increased for reduction of tetramethyl-p-benzoquinone. On the other hand, for the reduction of Fehling's solution that of the irradiated glucose decreased. Each degraded product except dihydroxyacetone showed inferior power to that of glucose not irradiated for both reducing reactions. The reducing power of dihydroxyacetone was 7 or 8 times as large as that of the nonirradiated glucose for this kind of radical reaction. Therefore, the increase in the reducing power of the irradiated glucose for the reduction tetramethyl-p-benzoquinone seemed to be attributable to the formation of dihydroxyacetone. (auth)

18014 RADIOLYSIS OF COBALT(III) ION IN AQUEOUS SOLUTION. Niro Matsuura (Tokyo Univ.), Nobuyoshi Shinohara, and Masao Takizawa. Nippon Kagaku Zasshi, 86: 259-60(Feb. 1965). (In Japanese)

Radioinduced reduction of the cobaltic ion in 0.8N sulfuric acid was investigated using ^{60}Co γ rays. The reduction yield of the cobaltic ion was strictly proportional to the absorbed dose up to 6×10^{18} ev ml^{-1}. Cobaltic solutions of 5×10^{-5} to 1×10^{-3} mol/l with and without dissolved oxygen were reduced to cobaltous state with equal yields of $G(Co^{2+}) = 2.3$. Lefort's mechanism for radiolytic reduction in 10^{-3} mol/l cobaltic solution was found to be applicable to the reduction in more dilute cobaltic solutions. (auth)

18015 RADIATION DAMAGE OF MYLAR AND H-FILM. A. M. Koehler, D. F. Measday, and D. H. Morrill (Harvard Univ., Cambridge, Mass.). Nucl. Instr. Methods, 33: 341-2(Mar. 1965).

Radiation effects on the strength and flexibility of Mylar and H-film (a polyamide, chemical composition $(C_{22}H_{10}N_2O_4)_n$) were investigated. Specimens of 0.001 in. thick Mylar and H-film were irradiated in a 160-Mev proton beam. The ultimate tensile strength was determined as a function of radiation dose. It was concluded that H-film is at least $1/10$ as sensitive to radiation damage than Mylar. (C.E.S.)

18016 STUDY OF THE KINETICS OF DISCOLORATION AT 1850 TO 9000 Å IN QUARTZ CRYSTALS IRRADIATED BY SLOW NEUTRONS OR ELECTRONS AT 2 Mev. F. Porreca (Università, Naples). Nuovo Cimento (10), 35: 398-409(Jan. 16, 1965). (In Italian)

Color centers A (~4200 Å) and C (~2000 Å) were induced in quartz crystals irradiated either by means of slow neutrons or of electrons of 2 Mev. The research method of the order γ of the annealing kinetics and the activation energy E of absorption bands are discussed on the ground of controlled processes of isothermal annealing, and results regarding the annealing of different samples between 130 and 265°C are given. In all cases, for the centers A, it was found that $\gamma = 2$, and E slightly decreases when temperature increases, with values ranging between (1.05 ± 0.10) and (0.80 ± 0.05) ev. On the ground of the model of the centers A suggested by O'Brien the annealing process is studied, and it is proposed that this is a diffusion phenomenon of second order. From experimental data, one can say that the annealing of centers C does not follow kinetics of first or second order, according to the prevision that their physical nature is more complex than that of the centers A. (auth)

18017 F CENTERS IN POTASSIUM CHLORIDE CRYSTALS IRRADIATED IN A REACTOR. T. Sh. Davitashvili and N. G. Politov. Opt. Spectry. (USSR) (English Transl.), 17: 474-8(Dec. 1964). Translated from Optika i Spektroskopiya, 17: 871-9(Dec. 1964).

The F band in the additive optical absorption spectra of potassium chloride crystals irradiated with neutrons in a reactor ($nv_{thermal} = 10^{12}$ neutrons cm^{-2} sec^{-1}) and a ZBP (D)-200 x-ray tube (65 kv, 10 ma) is studied. The parameters of the F band and their temperature dependence were determined in the interval from 85 to 300°K. It is shown that the half-width of the F band increases with increasing integrated neutron flux. Concepts about the interaction of the F center with the lattice are proposed as an explanation of the detected effect of change in the width of the F band. A comparison of the parameters of the theory was carried out for F centers with ideal and distorted surroundings. (auth)

18018 RECOMBINATION RADIATION IN ANTHRACENE CRYSTALS. W. Helfrich and W. G. Schneider (National Research Council, Ottawa). Phys. Rev. Letters, 14: 229-31(Feb. 15, 1965).

Fluorescence due to the recombination of electrons and holes in anthracene single crystals was observed. The crystals were melt-grown from chromatographed and repeatedly zone-refined material. Space-charge-limited electron and hole currents were injected into the anthracene through liquid electrodes contained in glass tubes cemented to the crystal surface. (D.C.W.)

18019 MOLECULAR WEIGHT DISTRIBUTIONS OF THE SIDE CHAINS OF RADIATION INITIATED GRAFT COPOLYMERS. J. D. Wellons, A. Schindler, and V. Stannett (Research Triangle Inst., Durham, N. C.). Polymer, 5: 499-503(Oct. 1964).

The grafted side chains of cellulose acetate–polystyrene grafts were separated from the cellulosic backbone by acid hydrolysis. The molecular weight distributions of the polystyrene resulting from a mutual and a preirradiation graft polymerization were determined using a column elution technique. Both samples had unusually broad molecular weight distributions; however, whereas the mutual product had a broad single distribution, the preirradiation sample had a two-peak distribution and had a large amount of polymer of very narrow and very high molecular weight. Some reasons for the differences are discussed. (auth)

18020 GAMMA RADIOLYSIS OF POLY-2-VINYLPYRIDINE. C. David, A. Verhasselt, and G. Geuskens (Université Libre, Brussels). Polymer, 5: 544-6 (Oct. 1964).

Gel point determinations and crosslinking-degradation ratios were determined in gamma radiolysis of poly-2-vinylpyridine. Irradiation was performed in sealed bulbs under vacuum with a ^{60}Co source at a dose rate of 0.25 Mr/hr. The gelling dose was found to be 2.5 Mr. A G value of 0.26 crosslinks per 100 ev was calculated. Poly-2-vinylpyridine was found to be 5 to 9 times less stable towards ionizing radiation than polystyrene. (M.C.G.)

18021 KINETIC MEASUREMENTS ON THE COBALT-60 GAMMA-INITIATED POLYMERIZATION OF ISOBUTENE IN THE PRESENCE OF ZINC OXIDE. F. L. Dalton (Atomic Energy Research Establishment, Wantage, Berks, Eng.). Polymer, 6: 1-13(Jan. 1965).

A dilatometric study was made of the rate of radiolytic polymerization of isobutene in the presence of zinc oxide with the samples being stirred during irradiation. Above a minimum stirring speed, the polymerization rate was not dependent on stirring rate. The dependence of polymerization rate on amount of additive used, radiation intensity, and temperature, was determined. Molecular weight data for the polymer samples obtained are given, and an hypothesis of the reaction mechanism is offered. (auth)

18022 BEHAVIOR OF UNSATURATED FATTY ACIDS IN THE THIOBARBITURIC ACID TEST AFTER RADIOLYSIS. L. D. Saslaw and V. S. Waravdekar (Armed Forces Inst. of Pathology, Washington, D. C.). Radiation Res., 24: 375-89(Mar. 1965).

Irradiation of linolenic and arachidonic acids resulted in production of several chromatographically distinguishable thiobarbituric acid (TBA)-active compounds. The ultraviolet radioinduced oxidation of the fatty acids was also characterized by increased absorption at 225 mμ and a positive benzidine test. Chromatographically different TBA-active products were obtained, depending on the radiation and the substrate employed. Despite the similarity of chromogen solutions obtained from the TBA-active products to that obtained from malonaldehyde, the presence of malonaldehyde among the products after either process of irradiation was not evident. After resolution of the TBA-active products on thin-layer chromatoplates, the TBA-active sites were observed to react with benzidine but did not liberate iodine from potassium iodide. In each irradiation process, the production of TBA-active compounds was accompanied by peroxide formation. However, the TBA-active compounds are not of a peroxide nature. Inasmuch as the TBA-active compounds react with standard reagents for detection of the carbonyl function, the TBA test must be regarded as a test for unidentified carbonyl compounds. (auth)

18023 NATURE OF THERMAL AFTEREFFECTS IN TRYPSIN SOLUTIONS IRRADIATED WITH X RAYS AND UV LIGHT. V. N. Luzikov (Inst. of Chemical Physics, Moscow). Radiobiologiya, 5: 11-16(1965). (In Russian)

X and uv irradiation of protein solutions formed H_2O_2, ROOH, and possibly stable radicals, which further inactivated native protein. Trypsin was comparatively stable to stable radicals but was inactivated by H_2O_2 and ROOH (tert-butyl) even at low concentrations on heating. Propyl gallate protected trypsin from post-irradiation inactivation in the presence of SH-containing compounds (cystein, reduced glutathione) that, even in very low concentrations, inactivate enzymes on heating. The after-effects of uv and x irradiation of trypsin solutions differed somewhat, i.e., the shapes of the kinetic curves, activation energies, and dependences of the magnitude of the after-effects on dose. (tr-auth)

18024 DEAMINATION OF AQUEOUS GLYCINE–Cu(II) SOLUTION BY GAMMA RAYS. Toshio Ikeda (Shizuoka Univ., Shizuoka City, Japan). Rept. Liberal Arts Sci. Fac. Shizuoka Univ., 3: 131-3(Mar. 1962).

Studies were made on the radiolysis of glycine-Cu(II) complex by measuring the amount of ammonia liberated when the aqueous solution was gamma irradiated (Co-60). Glycine-Cu(II) complex were adjusted to certain pH values by adding a desirable amount of 1M HCl or NaOH solution to 0.01 M glycine-Cu(II) solution. The resulting solutions were subjected to irradiation with ^{60}Co γ rays at room temperature and the radiolysis was followed chemically (by measuring the amount of ammonia) and spectrophotometrically (by measuring the change of spectra). The modified micro-Kjeldahl method was employed for the ammonia analysis, and the spectral change was followed at 400 mμ. The results indicated that the formation of ammonia is proportional to the dose of γ rays. When the doses were the same, the formation of ammonia was found to be independent of the pH of the solution. From the spectrophotometric study, it was also found that, when the solution is neutral, glycine-Cu(II) complex undergoes radiolysis to give free Cu. The effect of pH on the manner of spectrophotometric change was not a simple one. (Nucl. Sci. Abstr. Japan., 3: (Sept. 1964))

18025 THE RADIOLYSIS OF ACETYLENE IN SOLUTION. I. THE ACTION OF γ-RAYS ON AQUEOUS SOLUTIONS OF ACETYLENE. THE INFLUENCE OF THE IRRADIATION DOSE AND OF pH. Maria Fiti (Institut de Physique Atomique, Bucharest). Rev. Roumaine Chim., 9: 451-61(June-July 1964). (In French)

Solutions of acetylene in water (4.5×10^{-2}M) were sealed in glass ampoules and irradiated with ^{60}Co gamma rays at 6.5, 8, 12, and 22×10^{18} ev/ml hour. The quantity of glyoxal formed was a maximum at 1 hr for all data presented, and was higher for lower doses. The glyoxal G-value decreased monotonically with time and with increasing intensity; it also decreased with integral dose, reaching 0 at 5×10^{19} ev/ml. Polymer formation was also studied; over a period of 2 hr the quantity of soluble polymer increased with time and with dose (9×10^{-5} g/ml for 2.2×10^{19} ev/ml hr, 2 hr). The polymer G-value passed through a maximum near 1 hr for the highest dose but not for the other doses. The combined G-values also showed maxima with time for both highest and lowest dose. The quantity of polymer formed had a minimum at pH 5 and a maximum at pH 8; the quantity of glyoxal had a maximum at pH 2, a minimum at pH 4, and a maximum at pH 6.5, all for 2.2×10^{19} ev/ml hr. The glyoxal G-value had a minimum at 4 and a maximum at 8. The polymer G-value had a maximum at 2, a shallow minimum at 4, and a maximum at 6.5. The glyoxal G-value dominated the total G as a function of pH. The kinetic data and the structure and composition of the polymers indicated that glyoxal is involved in the polymerization; the hypothesis of Clay, Johnson, and Weiss (J. Phys. Chem., 63: 862(1959)) does not explain the data. (BBB)

18026 INVESTIGATION OF CHAIN REACTION RADIOLYSIS IN Sb AND Fe AQUEOUS SOLUTIONS. Matsura Nitiro, Kirimura Esi Sane, and Takidzava Macao. Rika Gaku Kenkyusho Hokoku, 39: No. 1, 35-9(1963). (In Japanese)

Gamma oxidation of Fe(II) and Sb(III), in air-saturated

H_2SO_4, to Fe(III) and Sb(V) was considerably increased by addition of KCl. The increase was dependent on the KCl concentration and was maximum with 0.02M KCl. In the Sb system, Sb(IV) formed by reaction of Sb(III) with the irradiation-produced OH is considered to be an intermediate. In the Fe system, the Fe(II) is considered to react with OH, H_2O_2, HO_2, and other products. The chloride may change the chemical nature of the Sb in solution or, after conversion to a free chlorine group by reaction with OH, oxidize the Fe(II) and Sb(III). (IIC-M.G.)

18027 RADIOLYSIS OF ETHYLENEDIAMINETETRAACETATOCOBALTATE(III). Hiro Matsuura (Tokyo Univ.) and Masao Takizawa. Sci. Papers Coll. Gen. Educ., Univ. Tokyo, 13: No. 2, 179-90(Dec. 1963).

Radiolysis of Co(III) EDTA and EDTA in 0.8N sulfuric acid solution was studied. Irradiations were carried out with one-kilocurie ^{60}Co at dose rates from 3.5 to 3.9 × 10^{14} ev/sec. Co(III)EDTA was readily reduced to the Co(II) state by irradiation. Decomposition of the scavenger Co(III)EDTA is proportional to the gamma dose. The G-values plotted against the scavenger concentrations show that the value approaches an ultimate value as the concentration is increased. The results of experiments indicated that the ligand EDTA is decomposed before the oxidation or reduction of the central metal Co(III) ion. The polarographic results provide evidence that the product of radiolysis is a Co(II) compound chelated with an undetermined ligand molecule other than EDTA–Co(II)Y'. For EDTA irradiated by γ rays, almost the same results were obtained. The G-values obtained from the hypothetical equation agreed well with those from experiments. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

18028 SELECTIVE MAIN CHAIN SCISSION OF POLYVINYL ALCOHOL INDUCED BY RADIATION. Ayao Amemiya (Tokyo Univ.) and Yutaka Hirano. Sogo Shikensho Nempo, 23: 30-3(Sept. 1964). (In Japanese)

Polyvinyl alcohols with different mole fractions of the head-to-head structure were irradiated in vacuo at room temperature with Co-60 gamma rays in order to investigate the effect of this anomalous structure on radiation-induced main chain scission of the polymer. A rapid approach to a certain value of G_d, the number of chain scissions produced per 100 ev of energy absorbed by the polymer, was observed with an increase in the head-to-head structure content in the polymer chain. Thus, it is postulated that there is a transfer of radiation energy from the head-to-tail structure to the head-to-head structure. The range of energy transfer was estimated from the G_d dependency on the concentration of the head-to-head structure. (auth)

18029 EFFECT OF LINEAR ENERGY TRANSFER (LET) ON THE H/D ISOTOPE EFFECT IN THE FORMATION OF HYDROGEN FROM IRRADIATED WATER. M. Anbar and D. Meyerstein (Weizmann Inst. of Science, Rehovoth, Israel and Soreq Research Establishment, Rehovoth, Israel). Trans. Faraday Soc., 61: 263-6(Feb. 1965).

The H/D isotope effects in the radiolytic formation of hydrogen from water by different radiations (γ rays, tritons, and alpha particles) were determined. The isotope effect was found to decrease with increasing LET (linear energy transfer). The implications of these findings on the mechanisms of the radiolysis of water are discussed. (auth)

18030 ELASTIC STRAIN AND COLORATION PATTERN IN NATURAL QUARTZ CRYSTALS. Ulrich Bonse (Cornell Univ., Ithaca, N. Y.). Z. Physik, 184: 71-84(1965).

Very small elastic strains (tilts of the order of 0.25 sec of arc and dilations $\Delta d/d \simeq 10^{-6}$, where d is the spacing of net planes) were observed in natural quartz crystals. According to their rocking curves which are of almost theoretical width, these crystals were commonly expected to be practically perfect crystals. On double crystal x-ray topographs a pattern was revealed of uniformly strained layers parallel to the rhombohedron faces (10$\bar{1}$1) and with thickness ranging between 20 and 200 microns. This fine structure strain pattern was correlated to the pattern of the optical coloration which could be produced by irradiating the originally transparent crystals with x-rays. A local increase of coloration matched with a local contraction of the lattice. Tilts occurred in transition zones between adjacent layers with slightly different lattice spacings. Strain and coloration patterns probably have as a common cause the deposition of layers with different impurity concentrations during the growth process of the crystals. Although no change of the strain as a result of the x irradiation could be detected in the colored layers in particular, experimental evidence was found for an overall expansion of the lattice of the order of $\Delta d/d \simeq 5 \times 10^{-7}$ due to x irradiation. This expansion seems to saturate at this low value and is probably caused by electronic processes connected with the coloration. Some aspects concerning the nature of the color centers were discussed. It seems likely from the results of the strain measurements that both sets of layers, colored and transparent ones, play a combined role in coloration. (auth)

18031 NUCLEAR EMULSION DEVELOPED IN AN AQUEOUS ALKALINE SOLUTION. Ya. M. Veprik, I. A. Guseva, A. P. Zhdanov, G. G. Martysh, and L. I. Shur (Scientific Research Inst. of Motion Pictures and Photography, Leningrad). Zh. Nauchn. i Prikl. Fotogr. i Kinematogr., 9: 207-8(1964). (In Russian)

Experiments were carried out on nuclear emulsions. The redox potential of p-oxyphenylglycine was determined over a wide range. The effects of the concentration of a developer and its pH on nuclear emulsions were studied, along with the change in sensitivity of a given emulsion before exposure. Solutions of p-oxyphenylglycine were introduced into an emulsion prepared for pouring at 50°C. The plates were dried at 20°C and exposed to alpha particles from ^{210}Po and light from an incandescent lamp. The best results were obtained with a 0.075M solution of oxyphenylglycine in 0.1N Na_2CO_3. The optimum development time was 80 min in a solution of pH 11. The density of the tracks on plates of ordinary emulsions decreased with time, while on plates containing the developer, the density was markedly increased with little increase in fogging. The emulsion with introduced developer was sensitive to alpha emission and needed no treatment in a developing solution. (M.C.G.)

18032 PHOTOCHEMISTRY OF THE NUCLEIC ACIDS. Kendric C. Smith (Stanford Univ., Palo Alto, Calif.). p.329-88 of "Photophysiology. Vol. II." New York, Academic Press, 1964.

Data published since 1960 on the photochemistry of nucleic acids are reviewed. Topics discussed include photoproducts reversed in the dark by acid or heat, photoproducts reversed by short wavelength light, the photochemistry of oligonucleotides and polynucleotides, the photochemistry of desoxyribonucleic acid, and the photochemistry of 5-bromouracil in vivo and in vitro. (165 references.) (C.H.)

18033 INTRODUCTION TO RADIATION CHEMISTRY. I. V. Vereshchinskii and A. K. Pikaev. Translated from Vvedenie v Radiatsionnuyu Khimiyu. New York, Daniel Davey and Co., Inc., 1964. 343p.

This book was previously abstracted from the original language and the abstract appears in NSA as 17: 40896. (M.C.G.)

18034 A PRACTICAL COURSE IN RADIATION CHEMISTRY. Farhataziz and P. J. Dyne. Lahore, Atomic Energy Centre, 1963. 40p.

Experiments for use in the study of radiation chemistry are described. They all use a gamma source. The nine experiments cover spectrophotometry, ferrous sulfate dosimetry, radiation shielding, effects of organic impurities on ferrous sulfate dosimeter, formation of phenol from solutions of benzene in water, reduction of oxygen in aqueous solutions by gamma radiation, ion chamber dosimetry, formation of nitric acid in the radiolysis of moist air, and the cesium nitrate dosimeter. Results obtained with these experiments in the Lahore laboratories are given. (M.C.G.)

18035 HALOGENATION OF IRRADIATED POLYMERS. Joseph Silverman (to W. R. Grace and Co.). U. S. Patent 3,156,636. Nov. 10, 1964. Filed Dec. 2, 1959.

A process for halogenating a polymer of an olefin having 2 to 3 carbon atoms, previously irradiated to an extent of at least 2×10^6 rad with high-energy irradiation, with a halogen having an atomic weight up to 80 is described. The halogenation process is carried out at room temperature and atmospheric conditions with either the pure halogen or one diluted up to 90% with an inert gas until at least 0.01% of the halogen is present in the polymer. The halogenation of the irradiated polymer renders it substantially impermeable to gases and aromatic flavors to which it is normally permeable; the polymer may be used in the form of film, tubing, containers, or other forms. The process is specifically described for the halogenation of irradiated polyethylene or polypropylene with Cl_2. (A.G.W.)

Radiochemistry

See also Separation Processes and Procedures.

Refer also to abstracts 17741 and 18260.

18036 (AECL-2210) SPENT NUCLEAR FUEL AS A SOURCE OF GAMMA RADIATION. W. M. Campbell and R. C. Hawkings (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 12, 1965. 19p. Dep.; $0.50(AECL).

The future Canadian power reactor program will be producing large amounts of gamma-emitting fission products which might be used in radiation processes. They will be available either as spent fuel elements or as concentrated mixed fission products, probably in the form of glass. The glass could have up to 10 times the radiation intensity of the spent fuel, but this is still much lower than that of ^{60}Co normally used for industrial purposes. Various factors associated with the use of this power reactor byproduct are discussed, and it is concluded that low radiation intensity is the main disadvantage. The real potential, however, can only be evaluated by a more detailed assessment of particular processes using fission product sources. (auth)

18037 (BNL-8467) A STUDY OF THE RECOIL REACTIONS OF THREE ISOTOPES OF RUTHENIUM IN RUTHENOCENE. Garman Harbottle and Ursel Zahn (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT-30-2-GEN-16. 21p. (CONF-773-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964.

Recoil reactions of three isotopes of Ru were studied in ruthenocene [$(C_5H_5)_2Ru$]. The isotopes, which were produced by (n,γ) reactions in the reactor, were ^{97}Ru (2.9 days), ^{103}Ru (40 days), and ^{105}Ru (4.45 hours), and their relative activities were determined through multi-channel analysis of the scintillation spectra. Crystals of ruthenocene were bombarded at different temperatures and locations, and the observed retentions were, for room-temperature conditions and single-step purification, ^{97}Ru, 9.5 ± 0.1, ^{103}Ru, 10.7 ± 0.2, and ^{105}Ru, 9.9 ± 0.2% respectively. Annealing the crystals at 140°C caused little increase in the retention, however it did produce another (unknown) Ru-labeled volatile metal-organic compound which could be separated from ruthenocene by repeated sublimation. When 2% solutions of ruthenocene in benzene were bombarded, the observed retentions were 0.61 ± 0.03, 1.04 ± 0.02, and 0.98 ± 0.02% respectively: these did not change significantly when a solution diluted tenfold to 0.2% was bombarded. In order to study the possible effect of the viscosity of the medium, 2% solutions of ruthenocene in benzene containing 2, 10, and 20% polystyrene were also investigated. Again, the results were quite similar to those for pure benzene. Frozen solutions of benzene (2 and 0.2% ruthenocene) were also studied: here the retentions approached those of ruthenocene crystals at the same temperature. If the isotope effect is defined as [1 − (retention of ^{97}Ru/retention of ^{103}Ru)] × 100 (in %) then the ruthenocene solutions have isotope effects averaging 42% against lower figures for crystals and frozen solutions. A possible explanation for the higher retention and lower isotope effect is the more effective removal of recoil momentum by a crystal lattice compared to a liquid, even a viscous one. (auth)

18038 (CEA-R-2620) APPLICATIONS MATHEMATIQUES EN RADIOCHIMIE. (Mathematical Applications in Radiochemistry). Jean-Marie Bonnieux, Francoise Communeau, Claudette Butaye, and Michel Valentin (Commissariat à l'Énergie, Atomique, Saclay (France). Centre d'Études Nucléaires). Dec. 1964. 71p. Dep.(mn).

The French little computer CAB 500 has been used to solve some mathematical problems connected with physical measurements in a radiochemical analysis laboratory. Programs have been written for: standardization by β−γ coincidences technique, unfolding of α spectra by a simple method, extrapolation of β absorption curve by the least squares method, gross activation, filiation problems, etc. (auth)

18039 (IITRI-578P15-12) RESEARCH ON A HOT-ATOM CATION-DEFIXATION METHOD FOR THE PRODUCTION OF ENRICHED Co-60 AND Ba-139. P. Y. Feng (IIT Research Inst., Chicago, Ill.). Jan. 4, 1965. Contract AT(11-1)-578. 61p. Dep.; $3.00(cy), 2(mn) CFSTI.

A modified Szilard-Chalmers process for the production of enriched radioisotopes is described which requires neither changes in the oxidation states of the elements involved, nor organic complexes with inherently low radiation resistances. This modified process is based on the ability of certain aluminum silicates to fix cations inside their lattice structures, and the subsequent defixation of the activated nuclei by means of nuclear recoil. Naturally occurring sodium potassium montmorillonite clay was converted to the corresponding cobalt (or barium) clay; the cations introduced were fixed inside the aluminum silicate lattice structure by calcination; and finally, after removal of the residual exchangeable cobalt (or barium) ions, the clay samples were irradiated. The cobalt-60 (or barium-139) nuclei released by the (n,γ) recoil process were eluted with dilute solutions of either HCl or NH_4Cl. Only experiments involving low integrated flux irradiations were carried out. Measurements of some sixty samples from over thirty experiments showed that the isotopes produced have generally been enriched as the result of this process. The highest specific activity achieved is calculated to be approximately 2.3 curies/gram for a sample irradiated for 8.25 hours at ANL at approximately 6×10^{13} n cm^{-2} sec^{-1}, corresponding to an enrichment factor of about 50. The highest experimental efficiency for Co-60 extraction was 9% as compared to the theoretical limit of 33% for the montmorillonite system on the basis of a simplified model. The conditions and results of the experiments suggest that the most important parameter by far is the effect of residual exchangeable cobalt ions in the clay sample. A systematic investigation using clay samples from routinely prepared material showed that the enrichment factors are apparently not appreciably affected by the neutron flux, length of irradiation, or the time elapsed between irradiation and processing. Comparison of the x-ray diffraction patterns of irradiated and unirradiated clays suggest that the structure of the aluminum silicate lattice is radiation resistant. Finally, existing knowledge in clay science indicates that this process should also be applicable to most other metallic elements. (auth)

18040 (NP-14707) PRIBLIZHENNYI METOD RASCHETOV SPECTROV ALPHA-IZLUCHENIYA TOLSTYKH IZLUCHATELEI. (Approximate Method of Calculating Alpha-Radiation Spectra from Thick Emitters). V. P. Grigorov Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). 1963. 11p. Dep.(mn).

A thick alpha emitter consisting of a known inactive material inside of which is distributed a known alpha-active isotope emitting monoenergetic α particles. The case is

considered in which the α particle is distributed uniformly and the activity depends on the depth h and is expressed by the known function of depth distribution A'(h). An approximate method for calculating pulse amplitude spectra was developed for the case in which the distribution density A'(h) is expressed by a complex function or in which the analytical expression of distribution is unknown. (R.V.J.)

18041 (CEA-tr-X-571) ABSORPTIVITE DE ^{144}Ce ET DE ^{147}Pm DES RECIPIENTS DE LABORATOIRE. (Absorptivity of Ce-144 and Pm-147 by Laboratory Containers). L. Neumann, O. Vojtech, and V. Brozek. Translated into French from Chem. Listy, 56: 692-4(1962). 8p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

The value of the absorptivity of ^{147}Pm and ^{144}Ce on different materials (glasses, polythene, and teflon) was determined by placing a sample of the material to be studied in a recipient containing a chlorided solution of the carrier-free radioisotope, kept at constant pH with no ultrafiltration or agitation. The results are tabulated and shown graphically. The mechanisms and kinetics of the absorption are discussed. (J.S.R.)

18042 RECOIL EFFECTS OF NEUTRON REACTIONS IN SODIUM BROMATE. Nobufusa Saito, Fumitoshi Ambe, and Hirotoshi Sano (Tokyo Univ.). Nature, 205: 688 (Feb. 13, 1965).

An investigation of the chemical distribution of radioactive bromine atoms arising from ^{79}Br(n,2n)^{78}Br and ^{79}Br(n,γ)^{80}Br reactions in crystalline sodium bromate is described. The effects of the irradiation and dissolution temperatures were investigated, and the recoil effects of both nuclear reactions were compared. However, attempts at low-temperature irradiation and dissolution resulted in no marked decrease of the retention values. The data indicate that in sodium bromate there exists no difference, within experimental errors, between the retentions for both reactions. (P.C.H.)

18043 THE BETA-GAMMA COINCIDENCE METHOD USED FOR THE STANDARDIZATION OF Au^{198} RADIOACTIVE SOURCES. I. Asavinei, L. Grigorescu, C. Lazarovici, M. Oncescu, and P. Sandru (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 857-66(1964).

A standardization method for ^{198}Au radioactive sources, in which the β-γ coincidence method and two photo-multipliers as detectors are used, is described. The realized variant allows the elimination of the γ background in the β crystal as well as the conversion electrons effect. The ^{198}Au sources can be standarized even in the presence of the ^{199}Au radionuclide. (auth)

18044 HANDBOOK OF RADIOCHEMICAL EXERCISES. An. N. Nesmeyanov, V. I. Baranov, K. B. Zaborenko, N. P. Rudenko, and Yu. A. Priselkov. Translated from the Russian by E. Kloczko. A Pergamon Press Book. New York, The Macmillan Company, 1965. 457p.

Experiments in radiochemistry are presented. They were planned so that they require the use of radioactive isotopes in amounts not exceeding fractions of a millicurie and weak neutron sources. The arrangement and equipment of a radiochemical laboratory, handling radioactive materials and safety techniques employed are discussed. The apparatus employed in radiometric measurements, properties of radiation, and laws governing nuclear transformations are considered. Experiments on chemical properties of radioisotopes are also presented. (M.C.G.)

18045 PROCESS OF INCREASING IN A COMPOUND THE PROPORTION OF AN ISOTOPE OF CARBON OR SULPHUR. Klaus Wetzel, Guenter Kretzschmann, and Roland Kiessling (to Veb Vakutronik). Canadian Patent 679,139. Jan. 28, 1964. Filed Apr. 1, 1961.

The purpose of the process is to increase the proportion of ^{12}C, ^{13}C, ^{14}C, ^{32}S, ^{34}S, ^{36}S in a compound by means of an isotope exchange reaction between carbon disulfide and a xanthogenate. The method lends itself to large scale operation involving few reactions. (F.S.A.)

Separation Processes and Procedures

See also Analytical Procedures.

Refer also to abstract 17783.

18046 (ANL-6829) ENGINEERING DEVELOPMENT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART 1. BENCH-SCALE INVESTIGATION OF A PROCESS FOR ZIRCONIUM–URANIUM ALLOY FUEL. D. Ramaswami, N. M. Levitz, J. T. Holmes, and A. A. Jonke (Argonne National Lab., Ill.). Dec. 1964. Contract W-31-109-eng-38. 60p. Dep.; $3.00(cy), 2(mn) CFSTI.

A fluid-bed fluoride volatility process for the recovery of uranium from highly enriched uranium–Zircaloy-2 and uranium–aluminum alloy fuels was developed. The conceptual process involves two basic chemical reaction steps conducted in a fluid-bed reactor. In the first step, the alloying material is separated as a volatile chloride by reaction with hydrogen chloride. In the second step, the uranium is recovered as its volatile hexafluoride by reaction with fluorine. Process development work conducted in a 1$\frac{1}{2}$-in.-dia nickel fluid-bed reactor with normal uranium–Zircaloy-2 alloys showed that recovery of greater than 99% of the uranium in the fuel can be achieved. High decontamination from fission products is expected on the basis of technology developed in previous studies. Considerable economic advantage of this process over current reprocessing schemes appears possible because (a) small waste volumes are produced, mostly in solid form; (b) considerable flexibility in process operating conditions exists; (c) overall fewer operations are needed; and (d) the product is uranium hexafluoride, which is readily amenable for isotope separation or conversion for reuse as fuel. (auth)

18047 (CRCE-1188) REMOVAL OF CHLORINE FROM ORGANIC COOLANT. J. H. Duerksen (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1964. 27p. (AECL-1912). Dep.; $1.00(AECL).

Trace concentrations of chlorine in organic-cooled systems promote the fouling of heat transfer surfaces and increase the hydriding of zirconium and its alloys. The purpose of this investigation was to find a suitable method for removing chlorine from organic coolant. Chlorine removal tests were done in capsules, in small loops, in the out-reactor 250-0-1 loop and in the X-7 loop in NRX. These showed that once chlorine entered an organic-cooled steel system it was not quickly or easily removed, emphasizing the importance of control to ensure its exclusion. The mild- and stainless-steel surfaces readily picked up some forms of chlorine contamination from the coolant. The most successful solid removers tested were a 0.5 wt % palladium-on-alumina catalyst and magnesium metal. Venting or purging successfully removed volatile chlorides. The fouling rates of coolants from various sources were significantly lowered by venting or purging and by exposure to palladium catalyst or magnesium. (auth)

18048 (HW-79029) ION EXCHANGE PURIFICATION OF PROMETHIUM IN THE 222-S BUILDING, 1-F CUBICLE. J. S. Buckingham (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). July 1, 1964. Contract AT(45-1)-1350. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The Np purification demonstration facility will be used to purify Pm by cation exchange chromatography. The equipment changes necessary are described together with the flowsheets using EDTA, DTPA, and HEDTA which will be tested. (D.L.C.)

18049 (HW-80298) PROMETHIUM PURIFICATION AT THE STRONTIUM SEMIWORKS. S. J. Beard, A. L. Boldt, and J. B. Kendall (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Jan. 15, 1964. Contract AT(45-1)-1350. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A preliminary engineering feasibility study was made for the installation of equipment in the Strontium Semiworks for the purification of megacurie quantities of ^{147}Pm obtained from wastes. In the purification, ^{147}Pm would be separated from rare earths by chromatographic ion exchange. Production capability, costs, and safety aspects were studied. (D.L.C.)

18050 (HW-83299) HAZARDS REVIEW. PROMETHIUM PURIFICATION DEMONSTRATION FACILITY. J. S. Buckingham (Hanford Atomic Products Operation, Richland, Wash.). July 15, 1964. Contract AT(45-1)-1350. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The chromatographic purification of promethium in the I-F cubicle will present a few unique hazards. Probably the foremost hazard is the difficulty in detecting the very soft beta emitted by promethium, and the resulting danger of losing contamination control. An adequate supply of special scintillation detectors and frequent thorough surveys should minimize this hazard. The conditions under which the ion exchange resin will be used will not constitute any hazard. The equipment is designed to contain any radioactivity that may result from an unusual situation such as equipment failure. Normal laboratory hazards will be present and the usual precautions will prevail. (auth)

18051 (ORNL-3623) CORROSION OF THE VOLATILITY PILOT PLANT INOR-8 HYDROFLUORINATOR AND NICKEL 201 FLUORINATOR DURING FORTY FUEL-PROCESSING RUNS WITH ZIRCONIUM–URANIUM ALLOY. E. L. Youngblood, R. P. Milford, R. G. Nicol, and J. B. Ruch (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 78p. Dep.; $3.00(cy), 2(mn) CFSTI.

Corrosion of the Volatility Pilot Plant process vessels was periodically determined during 40 processing runs in which uranium was recovered from both irradiated and nonirradiated zirconium and Zircaloy-2-clad fuel elements. The primary reaction vessels were the hydrofluorinator, constructed of INOR-8, which was exposed to gaseous hydrogen fluoride and an $NaF–LiF–ZrF_4$ molten salt mixture at 500 to 650°C, and the fluorinator, constructed of Nickel 201 (low-carbon nickel), which was exposed to fluorine and molten salt at about 500°C. Both the hydrofluorinator and the fluorinator were designed with substantial corrosion allowances. Based on the corrosion allowance remaining and maximum bulk-metal loss rates, the vessels should be suitable for at least 28 additional runs and possibly considerably more. So far, 40 runs have been made. Wall-thickness measurements were made primarily by ultrasonic measuring devices. Direct measurements were made by Vidigage, and remote measurements were made in the hydrofluorinator by a pulse-echo technique originally developed for use in the Homogeneous Reactor Test. Pitting, cracking and intergranular corrosion were studied visually with telescopes and mirrors, by radiography, by wax impressions, and by removal and examination of specimens. Hydrofluorinator corrosion rates were also determined from analyses of corrosion products in the salt. Corrosion data for Nickel 201 and other metal that had potential as fluorinator construction material were obtained from corrosion rods inserted in the fluorinator. Corrosion in the INOR-8 hydrofluorinator occurred primarily by bulk-metal loss. Cracking occurred in the lower 17 in. of the vessel, making it necessary to replace this section after 29 runs, but this cracking is believed to have been due to weld stresses on a substandard piece of INOR-8. The maximum corrosion rate of 0.14 mil/hr of HF exposure (38 mils/month of molten salt) occurred in the replacement bottom. The maximum rate for the remainder of the vessel after 40 runs was 0.028 mil/hr of HF (8.1 mils/month of molten salt or about 0.7 mil per run.) A few pits estimated to be not more than 20 mils deep or 20 mils in diameter, and several small fissures estimated to be not more than 10 mils wide, were seen in the lower section of the hydrofluorinator after 40 runs, but no extensive corrosion was observed. The Nickel 201 fluorinator had significant bulk-metal losses and intergranular corrosion. The weld filler metal 61 used for construction of the fluorinator was selectively attacked by aqueous solutions used to decontaminate the system. The maximum Nickel 201 bulk-metal loss of 0.9 mil/hr of F_2 exposure occurred in the lower vapor region after 14 runs. Two specimens cut from the lower fluorinator wall after 29 runs had a total corrosion rate (including intergranular corrosion on the inside and outside surfaces) of 0.28 to 0.56 mil/hr of exposure to F_2. Pits up to 10 mils deep were measured in the vapor section after 14 runs. (auth)

18052 (ORNL-TM-1027) CHEMICAL TECHNOLOGY DIVISION, UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, AUGUST–SEPTEMBER 1964. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 35p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The parameters affecting the rate of sorption and the total capacity of sodium fluoride pellets when used for UF_6 collection have been studied to provide design information for sorber beds. Five lots of pellets varying in specific surface area from 0.69 to 1.05 m^2g^{-1} and in void fraction from 0.375 to 0.45 were tested in 106 runs to provide data on the rate of sorption and effective capacity as temperature, UF_6 concentration, and gas flow rate varied. The experimental results are compared graphically with the results predicted by a mathematical model of the sorption system which had previously been established and described by equations suitable for computer solution. The experimental data and the model predicted data agree within a root mean square deviation of 12%. The data show that the effective capacity of the pellets decreases with increasing temperature and with increasing specific surface area. Effective capacity also decreases as pellet void fraction decreases. Induction heating of calcining pots for standard Potcal procedures or for rising-level glass processing in a pot is not satisfactory and the projected use of an inductively heated furnace for the Hanford Pilot Plant should be stopped. There have been two major failures with the direct heating of 16-in.-dia pots. Heating of 8-in.-dia pots with a 15-in.-dia susceptor was tested in runs R-85 and R-86. Internal foaming caused by high heat fluxes caused low rates for test R-85 and test R-86 was terminated after 8 hrs because a hole was burned in the induction coil between zones. (auth)

18053 (PAN-575/IXA-V) SEPARATION OF NEPTUNIUM FROM NEUTRON IRRADIATED URANIUM BY REVERSED PHASE PARTITION CHROMATOGRAPHY. S. Lis, E. T. Jozefowicz, and S. Siekierski (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research. Nov. 1964. 23p. Dep.

The method of quantitative separation of radiochemically pure neptunium-239 from neutron-irradiated uranium samples is developed using reversed-phase partition chromatography. TBP adsorbed on kieselguhr made hydrophobic is used as stationary phase, HNO_3 having different concentration as mobile phase. Neptunium is selectively reduced in the column from VI to V oxidation state. The behavior of some fission products creating special difficulties in the separation process was investigated, as well as the neptunium yield. (auth)

18054 (RL-SA-9) COUNTER-CURRENT CRYSTALLIZATION. W. L. Godfrey (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec 1964. Contract AT(45-1)-1350. 37p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A counter-current crystallization technique was developed for the separation of aluminum nitrate nonahydrate, an agent used in the Redox process, from fission products. The technique involves no solids handling problem and is capable of decontamination factors up to 10^5. The process development (laboratory and bench scale work) and design development (mathematical model) are described in detail. (D.L.C.)

18055 FOAM COLUMNS FOR COUNTERCURRENT SURFACE—LIQUID EXTRACTION OF SURFACE-ACTIVE SOLUTES. Paul A. Haas and H. F. Johnson (Oak Ridge

National Lab., Tenn.). A. I. Ch. E. (Am. Inst. Chem. Engrs.) J., 11: 319-24(Mar. 1965).

Foam separation processes use differences in surface activity to separate components of a solution. Stable foams can flow upward countercurrent to liquid to give countercurrent differential separations with stripping, enrichment, or scrubbing similar to solvent extraction. Six- and 24-in. ID foam columns were operated with sodium dodecylbenzenesulfonate solutions to measure height of transfer unit (HTU) values and foam densities and to develop satisfactory gas spargers, liquid feed distributors, foam drainage conditions, and foam condensation equipment. The HTU values for stripping of ^{85}Sr were about 1 cm for the best conditions of uniform foams, liquid flows of 100 gal/ft^2 hr or less, and uniform liquid feed distribution with low inlet velocities. Variations of countercurrent column lengths within 10 to 28 cm caused little variation in HTU values. The foams were condensed, with four types of pneumatic or mechanical foam breakers used. A pilot plant was designed for decontamination of a low level radioactive waste. (auth)

18056 GAS LIQUID CHROMATOGRAPHY AT LOW TEMPERATURES. RESOLUTION OF SOME DEUTERATED ETHANES. W. Alexander Van Hook and Margaret K. Kelly (Univ. of Tennessee, Knoxville). Anal. Chem., 37: 508-11 (Apr. 1965).

A technique for the gas chromatographic resolution of some of the deuterated ethanes is described. Chromatograms for the systems $C_2H_6-C_2D_6$; $C_2H_6-C_2H_4D_2$, 1,1d; and $C_2H_6-C_2H_5D$ are shown at various temperatures between 158 and 273°K. The separation factors, S, were calculated from the chromatograms and compared with the vapor pressure ratios, R. It was observed that lnS is consistently a factor of about 1.3 times lnR over that temperature range where a direct comparison can be made and it is pointed out that this result is in accord with the statistical theory of isotope effects in condensed systems. (auth)

18057 ION EXCHANGE SEPARATION OF FISSION PRODUCT RARE EARTHS WITH α-HYDROXYISOBUTYRIC ACID. Mark M. Zeligman (Univ. of California, Livermore). Anal. Chem., 37: 524-5(Apr. 1965). (UCRL-7749; UCRL-7749(Rev.1))

Separation of the light rare earths from each other was accomplished using milligram amounts of each available rare earth. The separations were accomplished using the technique of concentration gradient elution with Dowex-50 ion exchange columns and α-hydroxyisobutyrate solution as the eluant. By using fission products as radioactive tracers, it was found that good separations were achieved with peak-to-valley ratios of 10^2 to 10^4. (auth)

18058 A RAPID RADIOCHEMICAL METHOD FOR ANTIMONY AND ARSENIC. PART II. DEVELOPMENT AND TESTING OF THE METHOD. L. Tomlinson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Anal. Chim. Acta, 32: 157-64(Feb. 1965).

The formation of stibine and arsine by flash electrolysis was applied to the rapid separation of radioactive isotopes of antimony and arsenic from a mixture of fission products. A chemical yield of 45% for both antimony and arsenic was achieved in 10 sec. The conditions necessary for the clean separation of antimony and arsenic from one another and from other fission products are described. The method proved successful both in the laboratory and in a nuclear reactor. (auth)

18059 THE PURIFICATION AND RECONDITIONING OF PLUTONIUM. J. N. C. van Geel. Atomkernenergie, 7: 1-8(Jan. 1965). (In Dutch)

In the purification of plutonium the plutonium is separated from fission products and the purified plutonium put into an easily handled form. The processes used for this double purpose, especially ion exchange and solvent extraction, are described. (tr-auth)

18060 STUDIES OF THE SYNTHETIC INORGANIC ION EXCHANGER. IV. THE SEPARATION OF THE FISSION PRODUCTS AND URANIUM BY MEANS OF A STANNIC PHOSPHATE CATION EXCHANGER. Yasushi Inoue, Shin Suzuki, and Hidehiro Goto (Tohoku Univ., Sendai). Bull. Chem. Soc. Japan, 37: 1547-53(Oct. 1964).

The separation of fission products and uranium was carried out using a stannic phosphate cation exchanger. By using various concentrations of nitric acid and ammonium chloride solutions as eluants, the separation of uranium-strontium and uranium-cesium was easily performed, but that of uranium-rare earths was difficult. Among the various reagents investigated, a 1M phosphoric acid solution was found to be most suitable for the separation of uranium from rare earths. In view of these results, the separation of uranium and gross fission products was carried out; the resultant yield of uranium was more than 90%, and the decontamination factor was (2 to 3) × 10^3. (auth)

18061 THE CATION EXCHANGE ADSORPTION OF CALCIUM AND STRONTIUM FROM AN AMMONIUM FORMATE OR AMMONIUM ACETATE SOLUTION IN MIXTURES OF ORGANIC SOLVENTS AND WATER. Hiroyuki Tsubota (National Inst. of Radiological Sciences, Chiba, Japan). Bull. Chem. Soc. Japan, 38: 159-65(Feb. 1965).

Ion exchange equilibria of calcium-ammonium and strontium-ammonium exchange systems were studied in methanol-water, acetone-water, and dioxane-water mixtures in which acetate or formate ions coexist as a complexing anion. The selectivity coefficients of calcium against ammonium and those of strontium against ammonium decreased, while the separation factor between strontium and calcium increased, with an increase in the organic solvent concentration. Therefore, by column operation, calcium can easily be eluted from the column, and strontium can be well separated from calcium when a suitable elutant with a high separation factor between strontium and calcium and with a low selectivity coefficient of calcium against ammonium is selected. A 1:1 mixture of a 2M ammonium formate aqueous solution and acetone or a 1:1 mixture of a 2M ammonium acetate aqueous solution and methanol is recommended. When strontium in a large amount of calcium is to be analyzed, the latter is considered the more suitable. (auth)

18062 THE CATION EXCHANGE INVESTIGATION OF SCANDIUM ACETATE AND SULFATE SYSTEMS. Akira Tateda (Ehime Univ., Dogo, Matsuyama, Japan). Bull. Chem. Soc. Japan, 38: 165-71(Feb. 1965).

Ion exchange equilibria between the cation exchange resin, Amberlite IR-120, and an aqueous solution containing a small concentration of scandium ions and a relatively large concentration of acetate or sulfate ions were measured at a constant ionic strength of $\mu = 0.5$ and at 25°C. The values of the formation constants of the complexes in solution were calculated by the application of the Fronaeus method and by the graphical method. In the case of the acetate system, at an acetate ion concentration $[Ac] \leq 14.5 \times 10^{-2}$ mol/l and pH 4.5, species with scandium to ligand ratios of 1:1, 1:2, and 1:3 seemed to be formed. However, since scandium exists mainly in two ionic species, Sc^{3+} and $Sc(OH)^{2+}$, in the solution, the chemical formulas could not be determined; therefore, the formation constants were estimated for the addition of each formation constant of two complexes with the same ligand ratio, $Sc(Ac)_j^{3-j}$ and $Sc(OH)(Ac)_j^{2-j}$. The values of $B_j = (\beta_j + \beta_j {}^*K_1[H^+]^{-1})$ were $B_1 = 22 \pm 10$ mol^{-1} l, $B_2 = (15 \pm 7) \times 10^2$ mol^{-2} l^2, and $B_3 = (11 \pm 3) \times 10^3$ mol^{-3} l^3 at pH 4.5. In the case of the sulfate system, three complex ions were formed at a sulfate ion concentration of $[SO_4^{2-}] \leq 4.65 \times 10^{-2}$ mol/l and pH 2.7: $Sc(SO_4^{2-})^+$, $Sc(SO_4^{2-})_2^-$, and $Sc(SO_4^{2-})_3^{3-}$. The formation constants were $\beta_1 = 46 \pm 5$ mol^{-1} l, $\beta_2 = (11 \pm 6) \times 10^2$ mol^{-2} l^2, and $\beta_3^- = (10 \pm 7) \times 10^3$ mol^{-3} l^3. (auth)

18063 EXCHANGE AND EXTRACTION WITH LIQUID ION EXCHANGERS. EXTRACTION OF URANIUM, IRON, AND NICKEL. Charles Giannotti. Chim. Anal., 47: 25-34(Jan. 1965). (In French)

Liquid exchangers were classified into two groups: anion exchangers constituted by long-chain amines and cation exchangers essentially constituted by organophosphoric compounds; the naphthenic acids behave, under

well-defined conditions, as cation exchangers. The principal types of extraction with these exchangers are reported. (tr-auth)

18064 THE REDUCTION OF MONAZITE SAND WITH CARBON AT HIGH TEMPERATURE. Toshio Ishino and Hideo Tamura (Osaka Univ.). Denki Kagaku, 32: 149-54 (Feb. 1964). (In Japanese)

A series of processes involving reduction by carbon and chlorination was studied in attempts to separate efficiently rare earth, phosphorus, thorium, uranium, etc. from monazite sand. The results of these studies are given for the reduction by carbon. The amounts of carbon to be mixed, calculated on the basis of theory, were found to be suitable when assuming the chlorination reaction. The calculated carbon-to-monazite ratio was 0.43 for the monazite sand used in the experiment. Heating at above 1300°C after mixing the carbon to the above ratio is necessary to remove phosphorus by vaporization from the monazite sand. The higher the temperature, the better are the results. The optimum temperatures are over 1800°C. The carbon content of the products increases with removal of phosphorus. The extent of carbonization can be estimated from the phosphorus removal ratio. The highest removal ratio in the present experiment was 91%. (Nucl. Abstr. Japan, 3: (Nov. 1964))

18065 ON THE AUTOMATIC MONITORING AND CLASSIFYING APPARATUS OF LOW RADIOACTIVE LIQUIDS. REPORT I. Keiji Miyazaki and Setsuo Kawamoto (Hitachi Shipbuilding and Engineering Co., Ltd., Tokyo). Hitachi Zosen Giho, 25: 188-94(Aug. 1964). (In Japanese)

In a treatment and disposal system for radioactive liquid, it is sometimes required to monitor the radioactivities of liquids and classify liquids according to their intensities. Moreover, it is desirable to do this automatically and continuously. To investigate the technical feasibility of this concept, a continuous-monitoring and automatic-classifying apparatus composed of liquid-dip type radiation detector, a count-rate meter, electrical relays, and electromagnetic valves was made for trial and its performance was tested. Tests indicate that good performance is obtained from an appropriate combination of a dead band around the classifying level with a large time constant of the counting circuit. (auth)

18066 REPROCESSING OF HIGH BURN-UP FAST REACTOR FUEL. R. H. Allardice and I. G. Wallace (United Kingdom Atomic Energy Authority, Caithness, Scotland, U. K.). J. Brit. Nucl. Energy Soc., 4: 13-22 (Jan. 1965).

The Fast Reactor Chemical Plant was used to reprocess high-burnup fuel elements from the Dounreay Fast Reactor. The plant operating experience is reviewed with particular reference to the effects of increased activity levels on decontamination factors and solvent quality using 20% TBP/OK. Included are the results of a run carried out at reduced cooling times. (auth)

18067 CARRIER-FREE SEPARATION OF TITANIUM AND HALF-LIFE DETERMINATION OF ^{44}Ti. J. Wing, M. A. Wahlgren, C. M. Stevens, and K. A. Orlandini (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 27: 487-91(Mar. 1965).

The extraction behavior of titanium in HCl solution with 20% n-heptanol in petroleum ether was studied, using ^{44}Ti as an indicator. Over 90% of the carrier-free titanium in concentrated HCl solution was extracted into the organic phase in each equilibration. The half life of ^{44}Ti was determined to be 46.4 ± 1.7 years by a specific activity method with isotope dilution. The equilibrium γ activities of ^{44}Sc were measured by scintillation counters. The total titanium content was determined both spectrophotometrically and by addition of gravimetric standards. The isotopic composition of the titanium samples was analyzed using a 100-in. mass spectrometer. (auth)

18068 FERROCYANIDE MOLYBDATE, A NEW INORGANIC ION EXCHANGER. I. CHEMICAL COMPOSITION AND CRYSTALLOGRAPHIC STRUCTURE. L. H. Baetsle, D. Van Deyck, and D. Huys (S.C.K.-C.E.N., Mol, Belg.). J. Inorg. Nucl. Chem., 27: 683-95(Mar. 1965).

The product obtained after precipitation of $H_4Fe(CN)_6$ with Na_2MoO_4 in HCl solution displayed selective ion exchange properties for Cs in acid media. By varying the ratio of the reagents a series of products could be obtained, which had similar x-ray spectra. By combination of chemical analysis, density measurements, and unit cell determinations two structural models were found, which fit the experimental x-ray data. The first, called FeMo II, has the formula $\{[H_4Fe(CN)_6]_5[MoO_3(H_2O)_x]_{12}\}$ and the second, FeMo IV, may be written $\{[H_4Fe(CN)_6]_4[MoO_3(H_2O)_x]_{12}\}$. A correlation is given between the chemical constitution of the unit cells, the ion-exchange capacity and the stability range of the products. The molybdenum isopolyacid mostly found in these investigations corresponds to a Lindqvist type structure with an empirical formula $[Mo_6O_6(OH)_{16}]^{8+}$. (auth)

18069 SEPARATION OF AMERICIUM AND SOME RARE EARTHS FROM LANTHANUM BY REVERSED PHASE CHROMATOGRAPHY. Kenju Watanabe (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 45-50(Feb. 1965).

Reversed-phase column chromatography was applied to the separation of Am, Pr, Pm, and Eu from 5 to 110 mg of La carrier after coprecipitation. HDEHP (di/2-ethylhexyl) orthophosphoric acid) and TOPO(trioctylphosphine oxide)-xylene solutions held on kieselguhr were used as the stationary phase and the elutions were carried out with 0.1 to 1N nitric acid solutions. In the HDEHP system, Am could be separated from the rare earths except from Pr. Am could also be separated from Eu in the TOPO system. (auth)

18070 EVALUATION OF SEPARATION PROCEDURES FOR CHROMIUM(III) AND CHROMIUM(VI): PREPARATION OF RADIOCHROMIUM (CHROMIUM 51) OF HIGH SPECIFIC ACTIVITY. Mohan Khare and S. R. Mohanty (Banaras Hindo Univ., Banaras, India). J. Sci. Res. Banaras Hindu Univ., 14: 122-30(1963-64).

A comparative study of the separation procedures for Cr(III) and Cr(VI) was made. It was found that the method most suited for the preparation of radiochromium of high specific activity is neutron irradiation of solid chromates, followed by ion exchange separation of ^{51}Cr. (auth)

18071 SEPARATION OF THORIUM BY THE AMEX METHOD. TREATMENT OF MONAZITE. PART II. Kazutaka Kawamura and Takeji Takeuchi (National Research Inst. for Metals, Tokyo). Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku, 6: No. 4, 27-33(Sept. 1963). (In Japanese)

Studies were made of the extraction of Th with primary alkylamine (Primene JMT) from Th sulfate and monozite solutions (4.64 g. ThO_2/l) both treated with H_2SO_4. It was found that kerosene is most suitable as the diluent. The concentration of amine is adequate at about 0.2M. About 10 sec shaking is enough. When stripping Th from amine with HNO_3, the equal or half volume of HNO_3 is used. The shaking time is 2-5 min. For the regeneration of amine, it is shaken for 10 sec with ammonia water of equal concentration to that of amine. Scrubbing to remove rare earths is carried out by shaking with an equal volume of 0.014M HNO_3. By scrubbing 4 times, Th with a rare earth content of 12 ppm is obtained. The recovery of Th obtained from monazite is about 88%. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

18072 EXTRACTION OF TRIVALENT RARE EARTHS AND TETRA-VALENT CERIUM BY THE AMEX METHOD. Kazutaka Kawamura and Takeji Takeuchi (National Research Inst. of Metals, Tokyo). Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku, 6: No. 5, 329-36(Nov. 1963). (In Japanese)

In the extraction of trivalent rare earths (RE) with Primene JMT, such diluents as kerosene, n-hexane, cyclohexane, and xylene are relatively good, but there is little

difference among them. By using 0.2M Primene JMT in kerosene, the extractions of I and Ce(IV) were investigated. As the concentration of H_2SO_4 is increased, the amount of I extracted decreases. When the pH is low, RE cannot be extracted; pH's over about 1.0 are suitable. However, Ce(IV) is almost completely extracted when the concentration is low (ca 1.7 g/l); it is influenced by the H_2SO_4 concentration or the pH. Both RE and Ce(IV) can be completely back-extracted with HNO_3. The electrolytic oxidation of Ce(III) was examined: at 3.3 v of electrolysis voltage and 1.67 amp/dm^2 of current density, and in about 1.5 hr, about 78% Ce(III) in monazite-sulfuric acid solution free from Th was oxidized. In practice, about 80% of Ce could be extracted from the sample. The extract was scrubbed with 0.01$\underline{4}$N HNO_3 or 0.2$\underline{N}$ H_2SO_4. High-purity CeO_2 was obtained. (Nucl. Sci. Abstr. Japan, 3: (Nov. 1964))

18073 POISONING OF ION-EXCHANGE RESIN BY MEANS OF THE RADIOISOTOPE P-32. Aladar Imre. Magy. Kem. Folyoirat, 69: 285-92(July 1963). (In Hungarian)

During previous studies on the decrease of the exchange capacity of resins, chemical analysis revealed the presence or Zr and P in the ashes. The mechanism of this process was examined by means of a radioactive tracer technique by attempting to determine the extent of transient and permanent poisoning of the resin by phosphates and $ZrO_2 \cdot P_2O_5$. The ^{32}P tracer was used in the form of Na_2HPO_4. A polyfunctional, weakly basic anion-exchange resin and a resin consisting of divinyl benzene–polystyrene copolymer containing tertiary and quaternary amine groups, were used in the experiments. The sensitivity of the measuring system was 3.4×10^{-6} g of adsorbed P_2O_5 per gram of resin. The results indicated that the phosphate participates in the reaction in the form of the $H_2PO_4^-$ ion. The first resin was saturated in 2 hr, the second in 1 hr; the bound material was eluted in 5 and 6 hours, respectively. As a transient poison, the $H_2PO_4^-$ ions decreased the capacity of the resins by 0.22 and 0.27%, respectively; the irreversibly bound $H_2PO_4^-$ decreased the exchange capacity of the first resin by only 0.065% and that of the second resin negligibly. The resins were not mechanically poisoned by $ZrO_2 \cdot P_2O_5$. It was concluded that the phosphate poisoning must be attributed to a phosphate compound formed by a metal ion in the saturating solution. (TTT)

18074 PREPARATION OF COMPOUNDS OF REACTOR-PURITY. Laszlo Bakos and Elek Szabo. Magy. Kem. Lapja, 19: 433-8(Aug. 1964). (In Hungarian)

The relations between nitric acid concentration and the partition coefficients of 0.09 and 0.63M uranyl nitrate–38% tributylphosphate–xylene systems on the other hand, were investigated. The extractability of uranium showed no significant changes with changes in the acid concentration. A laboratory apparatus was constructed to establish the optimum processing criteria for uranium enrichment. Carbamide solutions were employed for re-extraction. The impurities of reactor-purity uranium trioxide were analyzed and discussed, employing chemical, spectroscopical, and activation techniques. (OTS)

18075 THE ISOLATION OF Zr–Nb-95 FROM MIXED FISSION PRODUCTS BY SOLVENT EXTRACTION WITH OXINE IN BENZENE SOLUTION. Toyoaki Kato (Tohoku Univ., Sendai). Nippon Kagaku Zasshi, 86: 209-12(Feb. 1965). (In Japanese)

The solvent extraction behavior of ^{95}Zr and ^{95}Nb with oxine in a benzene solution was investigated in order to establish the best procedure for the isolation of Zr–Nb from mixed fission products. By an equilibrium extraction with 0.2 mol/l oxine in benzene solution from aqueous acetate media, 92 to 98% of the Zr could be transferred to organic phase in the pH region of 4 to 10 and 95% of the Nb was extracted between pH 2 to 4.5; hence, the extraction of both the nuclides could be performed from an aqueous solution of the pH of about 4. The presence of citrate, tartrate, and oxalate caused interferences. Among the nuclides tested for their extractabilities with 0.2 mol/l oxine in benzene solution, Ce was quantitatively extracted in the pH range of 7.5 to 11, Y was completely extracted between pH 9.5 and 10.5 and about 30% of the Sr was also extracted in this pH range, but their extractabilities at the pH of about 4, as well as those of Cs and Ru were negligible. The repeated extraction at the pH 4 with 0.2 mol/l oxine in a benzene solution from an aqueous acetate solution of the mixed fission products treated with hydrogen potassium sulfate fusion resulted in quantitative transfer of Zr and Nb into the organic extract. Decontamination from the nuclides accompanied by Zr–Nb was carried out by the back washing the organic extract with an aqueous acetate solution of pH 4. Zr–Nb in organic extract could be easily removed by agitating it with 0.1 mol/l oxalic acid solution. Thus, the quantitative isolation of Zr and Nb with a high radiochemical purity could be attained by this extraction method. (auth)

18076 USE OF SOLUBLE POISONS IN FUEL PROCESSING. W. B. Lewis (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Sci. Eng., 21: 402-3(Mar. 1965).

A relation between the number of atoms of fissile material, hydrogen, and poison required to render a solution of fissile material subcritical is derived, using two-group diffusion theory. The amount of boron required to make a uranyl nitrate solution containing 400 g/l of ^{235}U subcritical is treated as an example. (D.C.W.)

18077 RADIOCHEMICAL STUDIES ON RADIOACTIVE MINERAL SPRINGS. III. LEACHING EXPERIMENT OF RADIUM FROM BASALTS AND SINTER-DEPOSIT. Itsuhachiro Hataye (Shizuoka Univ., Shizuoka City, Japan). Rept. Liberal Arts Sci. Fac. Shizuoka Univ., 3: 135-43 (Mar. 1963).

Leaching of Ra from basalt, nepheline-basalt, and sinter by various solutions is reported. The basalt from Fuji, Shizuoka-ken contained 0.28×10^{12} g Ra/g. The nepheline-basalt from Hamada, Shimane-ken contained 1.66×10^{-12} g Ra/g. The sinter (mostly $CaCO_3$) from the Yugakaye mineral springs, Shimane-ken contained 41.3×10^{-12} g Ra/g. To about 40 g of the powdered (100 ~ 150 mesh) sample 400 ml of a leaching solution was added, and the mixture was boiled under reflux for 10 hours. The mixture was centrifuged and the supernatant solution was allowed to stand for about a month to ensure equilibrium between Ra and Rn. Ra was then determined by using an electroscope. As the leaching solutions, water, dilute HCl solutions, and solutions of NaCl, KCl, $MgCl_2$, $FeCl_3$, Na_2SO_4, $NaHSO_3$, and $NaHSO_4$ were used. The extractability (in %) of Ra increased with concentration of the leaching solution. When a solution containing 106.0 g of $FeCl_3 \cdot 6H_2O$ in 400 ml was used, 74.90% of Ra was extracted from the basalt. When a HCl solution of pH 1.0 ~ 2.9 was used, 5.85 ~ 15.5% Ra was extracted from the basalt. Because of the low extractability of Ra from the sinter, it is considered that sinter is important as a source of Rn in the radioactive springs rather than as a source of Ra. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

18078 HAZARDS IN PROCESSING RADIOACTIVE MINERALS. J. K. Donoghue and D. H. Morris (United Kingdom Atomic Energy Authority, Springfields, Lancs, England). Trans. Inst. Mining Met., 74: 1-17(1964-65).

Hazards that may arise during the processing of radioactive minerals, and the measures taken to deal with them, are illustrated by reference to the production from uranium ore concentrates of nuclear fuel elements at the United Kingdom Atomic Energy Authority's Springfields Works. During the 17 years of its operation it has been possible to keep radiation exposures well within the limits recommended by the Medical Research Council and the International Commission on Radiological Protection. (auth)

18079 THE ANALYTICAL DETERMINATION OF SEPARATION FACTORS WITH NEUTRON ACTIVATION AND RADIOACTIVE LABELING FOR THE Zr–Hf SEPARATION BY DISTRIBUTION OF THEIR THIOCYANATES. K. Reinhardt. Thesis, Hanover, Technische Universitat, 1964. 112p. $2.00(Gmelin, AED-DISS. 64-205). (In German)

The distribution of Zr–Hf mixtures between thiocyanic acid solutions in water and in 2-methylpentanone is studied. Separation factors are not influenced by the weight quotient Zr/Hf for a larger value than 19. A method for Hf determination by neutron analysis is described. (Gmelin Inst.)

18080 INORGANIC OR ORGANIC CHELATING AGENTS AS ELUENTS FOR THE SEPARATION OF RARE EARTHS WITH ION EXCHANGERS. STUDIES WITH CONDENSATED PHOSPHATES. W. Pippig. Thesis, Mainz, Universitat, 1964p. $2.00(Gmelin, AED-DISS. 64-210). (In German)

Some polyphosphates, which are produced commercially on a large scale, are very effective complexing agents. Optimum separation with cation exchanger columns was obtained with pyrophosphate solutions with pH 0.9 and 5.0 for a temperature of 85°C. Peak width of rare earths is not broader for phosphates as for organic complexing substances, but separation factors are smaller. (Gmelin Inst.)

18081 REPROCESSING FACILITY, BUILDING 71 (Engineering Materials). (Dow Chemical Co. Rocky Flats Plant, Denver). (CAPE-1185). (34 DRAWINGS)

The expanded reprocessing plutonium purification plant is described along with some of the equipment, including rotary drum filters, glove boxes, process vessels, and piping. The 6 × 18 in. dia rotary drum filters were used in filtering plutonium peroxide solutions following precipitation of insoluble residues from leaching solutions during production purification. Glove box drawings show air locks, windows, glove ports, filters, frames, and sample take-out ports. Processing vessels and piping drawings show both horizontal and vertical tanks, ion exchange columns, vacuum knock-out pots, an evaporator, and a 400 gal chemical make-up waste tank. For details see TID-4100. (M.C.G.)

18082 PURIFICATION OF URANIUM YELLOW CAKE. Val Opratho and Lynn Price (to Rio Algom Mines Ltd.). Canadian Patent 685,437. Apr. 28, 1964. Filed Oct 18, 1961.

Before manufacture into reactor fuel yellow cake requires the removal of rare earths, Fe, Ti, Si, Al and other elements. Treatment with a carbonate gives a soluble complex, uranyl carbonate, and the impurities may be filtered off. Subsequent treatment with ammonia precipitates the uranium as the diuranate which is then refined further. (F.S.A.)

18083 PROCESS FOR OBTAINING PLUTONIUM IN THE FORM OF A CONCENTRATED SOLUTION. André Chesné (to Commissariat à l'Énergie Atomique). U. S. Patent 3,154,377. Oct. 27, 1964. Priority date Aug. 17, 1960, France.

A process for selectively extracting Pu from an aqueous nitric acid solution containing Pu in a valence state of 4, U, and other fission products is reported. The aqueous nitric acid solution is contacted with a solution of trilaurylamine in a water-immiscible organic solvent in order to extract the Pu into the organic phase. The organic phase is separated from the aqueous phase, and the Pu-loaded organic phase is washed with an aqueous nitric acid solution. The washed organic phase is contacted with an aqueous solution >0.1N of either sulfuric acid, perchloric acid, or a mixture of sulfuric and nitric acids. The acid solution has a redox potential sufficient to maintain the Pu in a valence state of 4. The concentration factor of the Pu was as great as 100 and the recovery was >99%. (A.G.W.)

18084 RECOVERY OF TRACE ELEMENT CATIONS. Murrell L. Salutsky and Maria G. Dunseth (to W. R. Grace and Co.). U. S. Patent 3,155,454. Nov. 3, 1964. Filed Nov. 21, 1962.

A procedure for the recovery of trace-element cations from dilute aqueous solutions, sea water, or other brines is described. Cations selected from the group consisting of Al, Ba, Ca, Cd, Ce, Co, Cu, Fe, Pb, Mn, Ni, Ag, Sn, U, and Zn and present in trace quantities were recovered by percolating the solution through a bed of magnesium ammonium phosphate and recovering the effluent. The cations displace the magnesium from the magnesium ammonium phosphate, are deposited on the bed in chromatographic-type bands, and may be recovered by treating the bed with ammonia. (A.G.W.)

18085 REMOVAL OF VANADIUM FROM AQUEOUS SOLUTIONS. James L. Hart (to Phillips Petroleum Co.). U. S. Patent 3,155,455. Nov. 3, 1964. Filed Dec. 12, 1960.

In the process described aqueous solutions of V are contacted with lead sulfate, lead carbonate, or lead phosphate contained in a permeable bed of an inert substrate. The lead salt in the bed is converted to lead vanadate, which remains in the bed until eluted with a suitable solvent such as sulfuric or phosphoric acid. The acid converts the vanadate to vanadic acid, and further acidifying of the elutant precipitates the vanadium as metavanadic acid. This acid can be melted and dehydrated to V_2O_5. The inert substrate for the permeable bed is preferably a particulate highly crosslinked polymer of a vinyl-substituted heterocyclic nitrogen base selected from the group consisting of the pyridine series, the quinoline series, and the isoquinoline series. The process is particularly applicable to the removal of soluble V values from the pregnant U-containing liquor of the carbonate leaching process and from the aqueous leach liquor obtained by leaching roasted yellow cake (sodium diuranate). (A.G.W.)

ENGINEERING

General

18086 (LA-3197) STRESSES IN THICK SLABS SUBJECTED TO THERMAL LOADINGS. Robert I. Brasier (Los Alamos Scientific Lab., Univ. of California, N. Mex.). July 1, 1964. Contract W-7405-eng-36. 132p. Dep.; $4.00(CFSTI).

The problem of thermal stresses in thick slabs is considered. A review of the currently used theoretical analyses and experimental techniques is presented. Experimental work is done using plastic models with electrical resistance strain gages. An important extension, to cover the case where a significant portion of the thermal energy is deposited in the interior of the body (as in the case of nuclear radiation), is made. A test was performed on a "thin" model for comparison with the theoretical result and good agreement obtained. Tests on a thick homogeneous model and on a thick reinforced model are reported. The effects of the increased thickness and the reinforcing are discussed. (auth)

18087 (WAPD-TM-421) AN INELASTIC CONTINUUM THEORY FOR DILATATING AGGREGATE MATERIALS. N. C. Small (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1965. Contract AT(11-1)-Gen-14. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The inelastic mechanical behavior of an aggregate material consisting of a weak "void" constituent exhibiting spontaneous dilatation embedded in a load-carrying matrix is described in terms of a suitably defined equivalent continuum. An existing inelastic continuum theory is modified to include the effects of compressibility and spontaneous dilatation. This theory is then related to the actual aggregate by assigning to each infinitesimal continuum element the desired gross or average behavior of a corresponding repeating finite aggregate element. Semirealistic analytical methods are used to simulate the real compressibility and spontaneous dilatation effects. Emphasis is placed on steady-state creep behavior, and a clad solid sphere is used to illustrate the advantages and limitations of the theory. From this example it is tentatively concluded that, with proper care, realistic results may be achieved at least for gross deflection rates and stresses in the external constraints. (auth)

18088 PRIMARY CREEP IN A SPHERICAL PRESSURE VESSEL WITH VARYING TEMPERATURE. S. D. Lee. Trans. Chalmers Univ. Technol., Gothenburg, No. 293, 1-23(1964).

The characteristics of creep of a spherical thin shell under constant internal pressure and varying temperature are discussed. It is shown that, when the temperature rises according to the exponential rule, a maximum value of stress will in most cases occur at a certain intermediate time. It was found that when the temperature distribution in the shell quickly approaches a stationary state, the maximum stress will differ little from that in the case of stationary temperature. Although a closed-form solution for materials displaying primary creep was not obtained, but only a series solution where transformed time τ is used instead of t, it was expected that most of the main features will remain. In the investigation it was assumed that the elastic constants do not vary with temperature, therefore all the results obtained can only be used for a comparatively narrow range of temperature change, approximately 50°C. Due to the assumption $\sigma_\phi - \sigma_r > 0$, the value of Φ could not be too large. It was concluded that it should be kept under $(1/\Delta)$, otherwise $\sigma_\phi - \sigma_r$ will become negative at the inner surface of shell. If the maximum value of Φ is $[k\theta_0 E\alpha/\Pi(1-\nu)] - 2$, and taking into account that $E\alpha/\Pi(1-\nu)$ is always smaller than 10^{-1}, then the change of temperature, $k\theta_0$, should be smaller than $10/\Delta$°C, which is always larger than 100°C in the case of thin shell. Therefore, if the elastic constants could be assumed not to vary with temperature, the value of $\sigma_\phi - \sigma_r$ could always be assumed to be positive. (auth)

18089 THE MAGNETOHYDRODYNAMIC PARALLEL PLATE SLIDER BEARING. D. C. Kuzma (General Motors Corp., Warren, Mich.). New York, American Society of Mechanical Engineers, 1964, Paper No. 64-WA/Lub-2, 3p. (CONF-763-46)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The effect of a nonuniform applied magnetic field on the operation of a parallel plate slider bearing is investigated analytically. It is found that the optimum magnetic field profile is a step function. This profile increases the load-carrying capacity while decreasing the friction factor. The results indicate that the nonuniform applied magnetic field is definitely superior to the uniform applied magnetic field. (auth)

18090 THERMAL ASPECTS OF MAGNETOHYDRODYNAMIC LUBRICATION. William T. Snyder (State Univ. of New York, Stony Brook). New York, American Society of Mechanical Engineers, 1964, Preprint 64-WA/LUB-9, 5p, $1.00. (CONF-763-47)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

An analysis is made of the temperature distribution in the lubricant film of a magnetohydrodynamic slider bearing. A solution is obtained for the conditions of adiabatic surfaces with axial conduction neglected. It is shown that under certain conditions of electrical loading of the bearing, the temperature rise of the lubricant with a magnetic field present may be as much as two orders of magnitude larger than the temperature rise without a magnetic field. (auth)

18091 A ¼ HORSEPOWER CLOSED CYCLE SOLAR HOT AIR ENGINE. Erich A. Farber and Ford L. Prescott (Univ. of Florida, Gainesville). New York, American Society of Mechanical Engineers, 1964, Preprint 64-WA/SOL-5, 7p, $1.00. (CONF-763-51)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

A 0.25-hp hot-air engine is described, and the operation and performance of the engine are discussed. (D.C.W.)

18092 NUMERICAL CALCULATIONS OF THE TRANSIENT LOADING OF BLUNT CYLINDERS BY SHOCKS IN AIR. Thomas Daniel Butler (Los Alamos Scientific Lab., N. Mex.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-4, 20p, $1.00. (CONF-650108-17)

From AIAA 2nd Aerospace Sciences Meeting, New York.

Results of the application of a numerical method for solving two-dimensional fluid dynamic problems to the problem of transient loading of blunt cylinders by shock waves are presented. The numerical method, a time dependent pure Eulerian technique, is applied using high speed computers. Two blunt obstacle geometries are considered under variable incident shock conditions: a cylinder of rectangular cross section, whose principal axis is aligned parallel to the plane of the incident shock, and a right circular cylinder, whose principal axis is perpendicular to the plane of the shock. In the case of rectangular cylinders, the calculations were compared with experimental results. In general, the agreement is seen to be quite good. For right circular cylinders, the calculations are in good agreement with analytical solutions. (auth)

Applications of Nuclear Explosions

18093 (LA-DC-6897) NEUTRON CROSS-SECTION MEASUREMENTS WITH NUCLEAR DEVICES. P. A.

Seeger (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract [W-7405-eng-36]. 13p. (CONF-650104-1) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Conference on Nucleosynthesis, New York.

The possibilities of using nuclear explosions as sources of neutrons for cross sections measurements are discussed. Basically the method is to detonate a nuclear device underground and bring the neutrons to the surface through a vacuum pipe 200 to 400 meters long. This is a single-pulsed reactor with a very high flux; the flux from a typical low-yield bomb is as much as could be produced in 25,000 years with an accelerator. (C.E.S.)

18094 (SC-RR-65-70) SCALING DIMENSIONS OF CRATERS PRODUCED BY BURIED EXPLOSIONS. Albert J. Chabai (Sandia Corp., Albuquerque, N. Mex.). Feb. 1965. Contract AT(29-1)-789. 53p. Dep.; $3.00(cy), 1(mm) CFSTI.

The question of the proper scaling of crater dimensions resulting from buried explosions is investigated. Dimensional analyses are performed from which four different scaling rules are derived. Data are reviewed in an attempt to distinguish which scaling rules are fundamental to cratering. Inability to perform cratering experiments with similitude apparently is one reason for lack of an unambiguous answer to the scaling question. Influence of possible sources of similarity violation are qualitatively examined, and some experiments are suggested which may provide more direct information about the correct scaling of crater dimensions. (auth)

18095 (UCRL-12118) SUMMARY REPORT — PROJECT ROWBOAT. Bruce Myers (Lawrence Radiation Lab., Univ. of California, Livermore). Oct. 5, 1964. Contract W-7405-eng-48. 123p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Rowboat was a high-explosive row-charge cratering experiment in desert alluvium. Its purpose was to study the effects of depth of burial and charge separation on crater dimensions. The experiment utilized 278-lb charges placed in a row and buried at equal depths and with equal separations. A total of eight linear craters were produced; four configurations were tested, with one repeat of each array to test reproducibility. The first two shots used optimum depth of burst and charge separation as predicted from single-crater theory. The shots produced similar craters which were the largest formed in Rowboat. The half-widths and depths of these craters were the only ones to scale with single-crater data. Shots 3 and 4 used optimum depth of burst, but the largest feasible charge separation. These shots produced smaller but similar craters with the expected saddles between shot points. Shots 5 and 6 tested the extreme end of the single-crater depth-of-burst curve with optimum charge separation. This depth of burst proved to be too large to produce even a recognizable crater. Shot 6 reduced the number of charges to three to test the effects of reduced row number. No significant change in crater cross-section dimensions resulted from the reduced row number. Shots 7 and 8 tested the intermediate depth of burst and charge separation. These shots produced craters that scaled somewhat below the single-crater data, indicating a sharper decline of linear cross-section dimensions with increased depth of burst than for the single craters. Shots 7 and 8 had single "normalizing" charges far removed from the ends of the linear array. The depths of the single craters formed by these shots compared well with the prevailing single-crater data. The radius of single crater 7 agreed with prevailing data, but that of shot 8 was higher than even the scatter of the data at this depth of burst. Support studies included surface motion photography, surface throwout measurements, and seismic measurements. The throwout measurements verified that very little throwout occurs at the ends of linear craters. They also showed the absence of uniform range dependence of the amount of throwout material deposited at the sides of the Rowboat craters. Studies of surface-motion photographs showed the peak velocities of ground zero surface and their related negative accelerations to be sharp functions of depth of burst. Large vents in several of the surface domes did not affect the surface velocities or the final craters formed. (auth)

18096 NUCLEAR EXCAVATION, 1963. 5 Reports Presented at the 43rd Annual Meeting, January 13-17, 1964. Highway Research Record Number 50. Highway Research Board of the National Academy of Sciences–National Research Council Publication 1172. (National Research Council). 1964. 53p. (CONF-378)

Five papers on nuclear excavation presented at the 43rd Annual Meeting of the Highway Research Board of the National Academy of Sciences–National Research Council are presented. Topics covered include: nuclear excavation technology, engineering properties and applications of nuclear reactions, Project Carryall, operations and safety problems associated with a nuclear excavation project, and construction and feasibility associated with nuclear excavation. Each paper was previously abstracted for NSA and appeared as abstracts 18: 12287, 12288, 12289, 12290, and 12291. (M.C.G.)

Facilities and Equipment

Refer also to abstract 19018.

18097 (CEA-R-2598) BILAN DES ENERGIES DANS LA CONNEXION DE CATHODE ET CALCUL DU RENDEMENT DANS LES DIODES A CESIUM. (Energy Balance of the Cathode Connection and Calculation of the Yield of the Cesium Diodes). Rene Merard (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). 1964. 16p. Dep.(mn).

The cathode is one of the critical elements in the calculation of the yield of cesium diodes. A study is made of the balance of the losses due to the Joule effect, to radiation, and to thermal conduction as a function of the shape and the nature of the cathode connection. The internal voltage drop of the diode is obtained from the expression for the total Joule losses of the metallic conductors. The length of the cathode connection is calculated as a function of the losses and the yield is optimized as a function of the relationship existing between the cathodic losses due to thermal conduction and the Joule losses in the connection. The calculations lead to hyper-elliptic integrals, which can only be manipulated by series development. The results obtained are approximate. (auth)

18098 (KAPL-3074) NEW LOW-ENERGY TOTAL NEUTRON CROSS-SECTION FACILITY AT KAPL — ITS CAPABILITIES OF HANDLING RADIOACTIVE NUCLEI. G. D. Hickman and B. O. Hannah (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 15, 1964. Contract W-31-109-eng-52. 45p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

A program that will yield total cross sections of both stable and radioactive nuclei has been described. A slow-neutron chopper having a 12-meter flight-path system has been designed and installed for use on the 10-kw Thermal Test Reactor (TTR). The system has been tested and is being used for stable-isotope measurements. The energy resolution of the system is ~3 to 5% in the energy range of 0.01 to 10 ev. A shielded-sample-changer cask for highly radioactive samples has been designed and is in the process of being constructed. It will have the capability of handling 10,000 Curies of 1-Mev gamma radiation. Some of the isotopes that can be investigated with this system have been given, along with some of the problems of sample preparation. (auth)

18099 (LA-DC-6382) HIGH-TEMPERATURE NEUTRON DIFFRACTION FURNACE. M. G. Bowman, W. G. Witteman, G. P. Arnold, and D. E. Hull (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract [W-7405-eng-36]. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An induction transformer has been developed to heat samples of refractory materials to temperatures up to 2100°C, permitting structural analysis at high temperatures by standard neutron diffraction techniques. (auth)

18100 (LA-DC-6396) LABORATORY HOOD VENTILATION. Robert N. Mitchell and Harry J. Ettinger (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract [W-7405-eng-36]. 10p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

The types of laboratory ventilation used to remove airborne contamination are outlined. The parameters involved in the design of chemical fume hoods are discussed; face air velocity, entrance configuration, sash, bypass, slots, materials, utilities, blowers, etc. Special hoods and maintenance are considered briefly. (D.L.C.)

18101 THE USE OF PLASTICS IN NUCLEAR TECHNOLOGY. H. Dominginhaus (Farbwerke Hoechst AG., vormals Meister Lucius and Bruening, Frankfurt am Main). Atomwirtschaft, 10: 76-81(Feb. 1965). (In German)

The uses of plastics in nuclear technology are discussed. Their advantages include ease of moulding, lightness of weight, corrosion resistance, high electrical and thermal insulation, and good damping characteristics. Certain characteristics, such as limited strength, dimensional instability under loading, high thermal expansion, poor resistance to the effects of heat, and radiation sensitivity, set limits to their sphere of application. Their main use is concerned with radiation protection. The smooth, non-porous, moisture repellant, and, chemically, highly stable surface of plastic parts provides an almost perfect solution to the requirement that contamination must as far as possible be easily and completely removable. In addition to apparatus and laboratory equipment, the floors and walls of working spaces can be protected by plastic materials. In addition numerous components of effluent water and air installations, such as filters, pumps, ventilators, and cyclones, are made from plastics because of their ease of decontamination. The handling of radioactive materials is made easier by use of cheap, light, and transparent plastic foils. Although the thermoplastic materials, polyethylene, polyvinyl chloride, and polymethyl methacrylate, predominate in technological radiation chemistry and in radiochemical laboratories, pure and fiber-glass-reinforced casting resins, in particular the epoxy resins, are used in accelerator installations and for numerous electrical components of such installations. (auth)

18102 THE GAMMA IRRADIATION FACILITY AT THE SWEDISH R2 REACTOR. C. G. Oesterlundh (Aktiebolaget Atomenergi, Studsvik, Sweden). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138(1963), 29-31(1964).

Fission products in spent fuel elements from the Swedish R2 reactor at Studsvik provide a large source of high-energy gamma radiation used for irradiation of large volumes. The fuel elements are used this way for the 90 days after discharge from the reactor and before shipment for reprocessing. The gamma energies range from 0.2 to 3.0 Mev. The irradiation can is a watertight aluminum cylinder. The dose rate was found to vary vertically along the can, but the highest dose rate was fairly constant over a length of 12 to 15 cm. (M.C.G.)

18103 STANDARDIZATION OF PLANNING FACILITY HANDLING RADIOACTIVE MATERIALS. Nobuo Okajima (Technical Research Inst., Taisei Construction Co., Ltd., Japan). Radioisotopes (Tokyo), 14: 33-41(Jan. 1965). (In Japanese)

The possibility of planning standardizations for radiochemical laboratories is explained, especially laboratories are classified according to low- and intermediate radiation level, and to the scale of small and intermediate facilities. Planning standardization is based on two premises, first of all, the condition that space requirements for research do not vary substantially with the type of research is considered to be most important. For this premise; planning standardization is based on standardization of equipment and criterion of radiation control necessary to protect workers from radiation hazard. Next major economies and flexibilities for any type of research facility can be effected by 3 S system, that is, standardization, simplification, and specialization of equipments. Application of these ideas is valuable in the design of laboratories as is shown in trial examples. A model of equipment was applied to an experimental bench, sink, and chemical hood and a model building planning was applied for room size control and room arrangement keeping close correlation with space model for experiment and research. The pattern of air current and velocity of ventilation must be controlled to keep contaminated aerosols from depositing on the floor of the room concerned, and to remove them by exhaust ventilation. For such requirements, correlation between air current velocity and room length along air current direction are checked by the method of ventilation control to the length of the room adopted in the design of the clean room. (auth)

18104 RADIATION FROM A DIRECTIONAL SOURCE: BEAM DIVERGENCE IN SOLAR SIMULATORS. R. P. Bobco (Hughes Aircraft Co., Los Angeles). New York, American Society of Mechanical Engineers, 1964, Paper No. 64-WA/Sol-3, 11p. (CONF-763-49)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

The analysis of thermal phenomena associated with radiation from sources which are imperfectly collimated is presented in a form convenient for engineering calculations. The analysis is developed in terms of beam divergence and directional intensity and applied to an hypothetical solar simulation system. Two different intensity distributions are postulated, and expressions are derived for solar constants and solar shape factors. The concept of shadowing is discussed, and a procedure is described for calculating both local and mean solar shape factors in penumbral regions. A simple L-shaped configuration is analyzed to illustrate the procedures and to examine the influence of beam divergence on equilibrium temperatures. Results are presented for both diffuse and specular surfaces and for several values of α^*/ϵ. (auth)

18105 CRYOGENIC SYSTEMS FOR REACTOR STUDIES. L. Weil (Faculté des Sciences, Grenoble, France). 12p. (CONF-554-14)

From Cryogenic Engineering Conference, Philadelphia, Aug. 1964.

The technology of systems for in-pile irradiation at low temperatures is surveyed, with reference to specific existing systems. The technical problems and their solution are stressed. (D.C.W.)

Heat Transfer and Fluid Flow

See also PHYSICS — General.

Refer also to abstracts 18558, 19282, and 19372.

18106 (AECL-2225) THE AMPLITUDE OF FLUID-INDUCED VIBRATION OF CYLINDERS IN AXIAL FLOW. M. P. Paidoussis (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1965. 19p. Dep.; $0.50(AECL).

A new empirical expression of the amplitude of transverse vibration of cylindrical beams and clusters of cylinders in axial flow for application to reactor fuel is described. The expression is based on reported experimental observations covering a variety of geometries, cylinder materials, and types of support in water, superheated steam and two-phase mixture flows. (auth)

18107 (ANL-6948) CONDENSATION OF METAL VAPORS: MERCURY AND THE KINETIC THEORY OF CONDENSATION (thesis). Donald J. Wilhelm (Argonne National Lab., Ill.). Oct. 1964. Contract W-31-109-eng-38. 159p. Dep.; $5.00(cy), 3(mn) CFSTI.

Submitted to Ohio State Univ., Columbus.

Condensation data and condensation theories concerning metal vapors were extensively reviewed. Nusselt's and improved theoretical film-condensation heat transfer rates for metal vapors were roughly five to 30 times as large as observed experimental rates. Because this discrepancy has been attributed by some researchers to a controlling resistance at the vapor-liquid interface, described by the kinetic theory of condensation, the latter concepts were

also critically reviewed to clarify the concept and nature of this resistance. In addition to the mass transport equation, commonly used, the kinetic theory equations of momentum and energy transport across the vapor-liquid interface in film condensation were written, and the composite velocity distribution for vapor at the interface was normalized. The simultaneous solution of these equations depends strongly upon the velocity distribution of vapor molecules reflected from the liquid surface. Solutions of these equations for six different cases, two of which permitted inelastic reflection, failed to yield physically consistent answers for heat flux and overall thermal driving force. A parametric study of these equations yielded expected trends in the "condensation coefficient" (the fraction of molecules striking the interface that actually condenses). The available mercury film-condensing data of Misra and Bonilla and the recent data of Sukhatme and Rohsenow were analyzed in the manner of the parametric study. It was shown that heat transfer coefficients and condensation coefficients calculated from data cannot be directly compared without regard for the system conditions. Because the two series of data were obtained over significantly different pressure ranges, Misra's data remain to be checked. The literature survey and subsequent analyses revealed serious shortcomings in the kinetic theory of condensation. Supporting reasons were not found for the common assumption that the condensation and evaporation coefficients are identical. An adequate theory of condensing vapor transport at the vapor-liquid interface remains to be developed. Sukhatme's data and the literature review of condensation coefficients indicated that collisional energetics ought to be considered in any theory of the condensation coefficient. Moreover, published results of molecular beam determinations of condensation coefficients, particularly in condensation-crystallization studies, suggest that surface migration of adsorbed vapor is an important mechanism in dropwise condensation. Design details and operating difficulties of mercury vapor rotating disk condenser tests (which comprised the original and a major portion of this program), aimed at evaluating the vapor-liquid interfacial resistance, have been included. (auth)

18108 (BAW-3238-6) NONUNIFORM HEAT GENERATION EXPERIMENTAL PROGRAM. Quarterly Progress Report No. 6, October–December 1964. D. F. Judd, R. H. Wilson (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.; H. S. Swenson, R. A. Lee, and J. W. Ackerman (Babcock and Wilcox Co., Alliance, Ohio. Research Center). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3238. 43p. (EURAEC-1327). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A program for experimental and analytical investigations to determine the effects of irregular heat flow through reactor channels on the operating conditions that cause burnout (departure from nucleate boiling) is discussed. This program seeks to improve design correlations that will be suitable for direct use by reactor designers. Tubular specimens with four axial power shapes and annular specimens with five power shapes are being used, and an effort to correlate the experimental data with empirical and analytical models will be made. Data were obtained from two test sections, one with the peak heat flux near the inlet and one with the peak heat flux near the outlet. A bridge circuit was added to the test section monitoring system in an effort to provide more information about the critical heat flux condition. (auth)

18109 (CONF-654-53) NEUTRON BEAM ATTENUATION AS AN OUT-OF-PILE VOID FRACTION DETERMINATION TECHNIQUE FOR BOILING WATER. William T. Sha and Charles F. Bonilla (Columbia Univ., New York). [1963]. Contract AT(30-3)-187. 21p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

A new method for determining the steam, or void, fraction in a boiling-water out-of-pile test section has been theoretically analyzed and experimentally verified with air voids at room temperature. The method utilizes the combined moderation and attenuation of neutrons from an Sb–Be source by the boiling water, in which boron has been dissolved. It is found that the method is applicable to multi-rod test sections with void fractions up to 25% or more, and is sensitive enough to detect void fractions as small as 3% or less. (auth)

18110 (EURAEC-1248) PROGRESS IN WORK UNDER WAY FOR THE THIRD QUARTER 1964. Quarterly Report No. 18. (Société Nationale d'Etude et de Construction de Moteurs d'Aviation, Suresnes (France). Division Atomiques). Nov. 4, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 061-64-7-TEEF. 4p. Dep.(mn):, $1.00(cy), 1(mn) CFSTI.

After the first visualization experiments on air–water two-phase flow in a plexiglass channel (tube ID 20 mm with a twisted tape) at atmospheric pressure, the separator and riser were modified to avoid flow oscillations. The loop was operated to complete void fraction measurements (gamma-ray attenuation technique) and all components of the detection system were assembled. Calibration was carried out. A probe was designed to evaluate the liquid film thickness along the tube and the twisted tape and to determine whether or not different flow patterns exist. A test section was designed to study mass flow-rate redistribution in a nine-rod cluster, with air and water at atmospheric pressure. Two test sections for thermal test (circular tube ID 20 mm with a twisted tape and a nine-rod cluster with twisted tapes) were also designed. (auth)

18111 (GEAP-4778) A PROGRAM OF TWO-PHASE FLOW INVESTIGATION. Quarterly Report No. 7, October–December 1964. G. Bijwaard, F. W. Staub, and N. Zuber (General Electric Co., Schenectady, N. Y. Advanced Technology Labs., and General Electric Co., San Jose, Calif., Atomic Power Equipment Dept.). Jan. 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 96p. (EURAEC-1326). Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The results of the analytical investigations which have been carried out during the first contract year are summarized. Additional still and high-speed motion picture photography was carried out at constant heat input in the glass test section. Nucleation in the annular flow regime was studied in this photography work. Subsequent to the installation and check-out of the new condenser, the oscillatory heat input tests were initiated on schedule in the metal test section. To date, all the planned tests at a reduced pressure of 0.25 have been completed as well as about 40% of those at a reduced pressure of 0.12. Only the information at the higher reduced pressure is discussed. The method of transient void data reduction is also discussed. A propagation equation is presented which describes the transient behavior of the vapor volumetric concentration in a two-phase flow system with a change of phase. This propagation equation, which is formulated in terms of kinematic waves, predicts the void response to variations of: 1) power density, 2) pressure, 3) pressure drop, 4) energy storage in the liquid and in the vapor, 5) compressibilities of the liquid and of the vapor, 6) friction factor, 7) flow regime, and 8) gravitational force field. The results of the analysis show that: (1.) The rate of propagation of the voids, as well as the change, i.e., the distortion of the void disturbance as it propagates along the duct, can be predicted by means of kinematic waves. (2.) The void response can be predicted if the steady state voids can be predicted. (3.) The void response depends, definitively, upon the flow regime, and it may change, completely, with a change in flow pattern. (4.) A change in two-phase flow pattern may occur whenever variation of voids cannot propagate through the mixture. (5.) The void propagation equation, together with the momentum, energy, and continuity equations for the mixture, and with the equation of state, describes the dynamic behavior of the system. The results, predicted by the

void propagation equation, are in the process of being compared to experimental data. (D.L.C.)

18112 (KR-85) "VOIFLO I"—A STEADY STATE FORTRAN CODE FOR THE HYDRAULICS OF A BOILING LOOP. K. O. Solberg, P. Bakstad, and J. Rasmussen (Institutt for Atomenergi, Kjeller (Norway)). Dec. 1964. 65p. Dep.(mn).

A description is given of a digital computer programme "VOIFLO I," which computes the steady state hydraulics of a boiling loop consisting of a heated channel, a riser part, and a downcomer. The "VOIFLO" code calculates the circulation velocity and the detailed distributions of quality, void fraction, water velocity, slip ratio, and pressure along the flow path. Inputs to the code are the power distribution, geometrical, and material data. The code is written in FORTRAN. Subcooled boiling, water flashing, and variable slip along the channel are included; these are important effects under certain conditions. Great care has been taken to make the computing time a minimum, which is obtained by choosing appropriate main variables and solving the equations in a manner to avoid unnecessary iterations. The code was made flexible so that changes can be easily done in the slip formulas or in pressure losses in which measured values can be substituted. Comparisons with experimental data from loops show that very good agreement can be obtained. Certain parameters in the slip and friction correlations must, however, be chosen as dependent upon the experimental conditions (pressure and geometry). The need for high precision measurements is realized to obtain general correlations for slip and two-phase friction. (auth)

18113 (LA-3167) MULTIREGION ANALYSIS OF TEMPERATURE FIELDS AND HEAT FLUXES IN TUBE BUNDLES WITH INTERNAL, SOLID, NUCLEAR HEAT SOURCES. Roy A. Axford (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Sept. 8, 1964. Contract W-7405-eng-36. 79p. Dep.; $3.00(cy), 2(mn) CFSTI.

A two-dimensional, coupled, multiregion analysis of the fully developed temperature and velocity fields in triangular tube bundles with internal, solid nuclear heat sources is presented. Analytical and numerical results for the circumferential variations in the inside and outside tube wall surface temperatures, the tube-wall temperature drop, and the inside and outside tube wall heat fluxes are given. The sensitivity of these variations to the pitch-to-diameter ratio of the tube bundle for both the slug flow and the laminar flow coolant cases is investigated. (auth)

18114 (MIT-3357-1) THE EFFECT OF SURFACE CONDITIONS ON NUCLEATE POOL BOILING HEAT TRANSFER TO SODIUM. Technical Report No. 5219-33. Paul J. Marto and Warren M. Rohsenow (Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering). Jan. 1965. Contract AT(30-1)-3357. 173p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

A simplified theoretical model for bubble nucleation stability was proposed, and an approximate stability criterion was developed. This criterion contains both fluid and surface properties, and it predicts that nucleation for sodium should be unstable. Commercial grade sodium was boiled from a horizontal disc at pressures of 65, 200, and 400 mm Hg absolute, with sodium temperatures ranging from 1200 to 1500°F. Heat fluxes as high as 236,000 Btu/hr ft^2 were attained. Boiler surface finishes ranged from highly polished mirror finishes to coarse, porous coatings. By following a prescribed cleaning and filling procedure, nucleate boiling results were generally reproducible for a given type surface. The effect of roughness as well as any aging and hysteresis effects were experimentally determined. Incipient nucleate boiling results are discussed as well as the effect of pressure and pool depth on the nucleate boiling curve. The effects of surface material, chemical treatment, heat flux, and cavity geometry on nucleation stability were measured, and the experimental results agreed with the predictions of the proposed stability model. (auth)

18115 (NP-14607) HEAT TRANSFER MEASUREMENTS IN PARTIALLY IONIZED GASES. Research Report 196. P. H. Rose and J. O. Stankevics (Avco-Everett Research Lab., Everett, Mass.). Oct. 1964. Contract NAS-w-748. 47p.

Convective energy transport in a high temperature partially ionized gas is considered. Certain uncertainties, particularly with respect to the effect of the surface material of the heat transfer gage, are studied. An experimental investigation is made of a technique of making heat transfer measurements to bear on this problem. The infrared heat transfer gage has been adapted to the experiment. An analysis is presented which demonstrates the response required of the measurement in order to enable accurate heat transfer measurements to be made within the limited test times available. The difficulties of adapting the gage to the requirements are described, in particular the sensitivity, opacity, and adherence of the gage to the MgO window. The calibration of the absolute magnitude of the output of the infrared cell as well as the response time of the measuring system are described. The response of the gage to the heat transfer encountered in both the shock tube end wall and on a model are discussed with emphasis on the identification of radiative heat transfer effects. Variations of the gage surface material achieved by overcoating the carbon with thin metallic films did not change the heat transfer rates measured. In view of the fact that the metallic films used do not change the calibration of the gage this is felt to be a conclusive result regarding the effect of surface materials. (auth)

18116 (NP-14693) TEORIYA DIFFUZIONNOGO OSAZHDENIYA PRODUKTOV RASPADA BLAGORODNYKH GAZOV V KRUGLOM I PLOSKOM KANALAKH. (Theory of the Diffusion Deposition of Noble-Gas Decay Products in Curved and Flat Channels). V. M. Berezhnoi and V. N. Kirichenko (Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). [1963]. 6p. Dep.(mn).

Diffusion of various atoms formed in a laminar gas flow through a curved or flat channel was investigated. The equations developed for the penetration and distribution of atoms deposited along the channel walls were used for determining the diffusion coefficients of atoms of noble gas decay products and for estimating the deposition in the test channel. (R.V.J.)

18117 (NP-14816) STABILITY OF A CONDUCTING FLUID FLOWING DOWN AN INCLINED PLANE IN A MAGNETIC FIELD. Report No. 85-29. Din-Yu Hsieh (California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science). Dec. 1964. Contract Nonr-220(28). 27p.

A stability analysis is made for the laminar flow of a layer of a viscous and electrically conducting fluid down an inclined plane in a transverse magnetic field. It is found that the effect of the magnetic field, revealed through the Hartmann number, is to stabilize the flow. A simpler and physically clearer approximate treatment of the same problem based on the principle of local balance is also given. The results agree quite satisfactorily with the exact analysis. (auth)

18118 (PAN-519/IX) EKSPERIMENTAL'NOE ISSLEDOVANIE PORISTOSTI TSILINDRICHESKOGO PROSTRANSTVA ZAPOLNENNOGO SHARSVYMI ELEMENTAMI. (Experimental Investigation of the Void Fraction in a Bed of Randomly Packed Spheres). B. Ruzhanski (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Oct. 1964. 10p.

The dependence of the void fraction of randomly packed spheres on the basis of an experimental investigation is discussed. The experimental investigations have shown that the considered void fraction is a function of the packing dimensions/diameter of the vessel and spheres. The formula for the determination of the void fraction in the case of cylindrical packing has been obtained as a result of the investigation. (auth)

18119 (SAN-409-17) HIGH ACCELERATION FIELD HEAT TRANSFER FOR AUXILIARY SPACE NUCLEAR

POWER SYSTEMS. Quarterly Technical Report, September 1–November 30, 1964. H. F. Poppendiek, N. D. Greene, C. M. Sabin, F. R. MacDonald, L. V. Feigenbutz, R. K. Livett, P. E. Schwartz, and D. J. Connelly (Geoscience Ltd., Solana Beach, Calif.). Contract AT(04-3)-409. 30p. (GLR-32). Dep.(mn); $2.00(cy), $(mn) CFSTI.

A limited amount of helical forced-flow boiling potassium data is presented and compared with mercury data. The previously developed fog flow model was modified to account for heat sink profiles which are variable instead of uniform with respect to radial position. The equations resulting from the analysis of the model were evaluated for specific conditions in order to determine heat sink and temperature profiles. New equipment has been constructed for the determination of the vaporization lifetimes of potassium droplets. This equipment was used to measure the lifetimes for a range of temperature and surface conditions. These data are presented together with a description of the physical behavior of the droplets while being vaporized. The data indicate that for some surfaces the lifetime of a particular droplet is affected by the number of droplets which have been previously vaporized on the surface. (auth)

18120 (UCRL-13144) REFINEMENT OF THE p-V-T-t PRIMARY METHOD FOR MEASURING THE MASS FLOW RATES OF GASES. Final Report. B. T. Arnberg (Colorado Univ., Boulder. Engineering Research Center). Dec. 31, 1964. For Lawrence Radiation Lab., Univ. of California, Livermore. 49p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

An indirect method is treated in which the mass of gas is determined from pressure, volume, and temperature measurements in conjunction with equation of state data. The gas must be thoroughly purified to establish confidence in the applicability of the equation of state data. Critical flowmeters were used for transfer standards. The pressure measurements required for both the primary method and the transfer standard had the predominant effects on the overall systematic error. The receiver temperature measurements were the second most critical measurement from the viewpoint of systematic accuracy. The volume calibrations required detailed attention to technique to establish confidence in the result, as there were many possibilities for mistakes and oversights. The estimated mean square systematic errors, using quadrature addition, were ±0.025% for the primary method, and ±0.089% for the sum of the systematic errors in both the primary method and transfer standard. When linear addition was used instead of quadrature addition, the corresponding estimated errors were ±0.07 and ±0.16%. The method was checked by initially charging one group of tanks, evacuating a second group, and then equalizing the pressures between them. Comparison of the mass determined from the initial measurements with the mass determined from the measurements made after the pressures were equalized indicated the sum of the systematic and random errors. The results of these tests showed the measurements to be very precise, and the errors to be within the range of magnitudes indicated by the error analysis. It is believed that a very high confidence of an overall systematic error of less than 0.25 percent can be maintained in the transfer standard when calibrated by this method, and that this confidence can be extended to an accuracy of 0.1 percent by obtaining cross-checks with other primary methods. (auth)

18121 (FTD-TT-64-395) BIBLIOGRAPHY OF PUBLICATIONS ON THE SUBJECT OF HEAT AND MASS EXCHANGE. R. A. Dolinskaya. Translated from Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR, 6: 127-34(1963). 21p. CFSTI.

A total of 169 references is presented. Among the topics covered are mathematical analytic methods, thermodynamics, experimental methods, phase conversion, chemical conversion, drying processes, high-temperature processes and magnetohydrodynamics, reactor processes, etc. (D.L.C.)

18122 HEAT TRANSFER IN A RADIATING FLUID WITH SLUG FLOW IN A PARALLEL-PLATE CHANNEL. R. Viskanta (Argonne National Lab., Ill.). Appl. Sci. Res., Sect. A, 13: 291-311(1964).

Fully developed heat transfer in slug flow in a flat duct between two parallel plates was considered. The flat duct consisted of two diffuse, nonblack, isothermal surfaces. The gray radiating fluid between them was capable of emitting and absorbing thermal radiation. The problem was formulated in terms of a nonlinear integrodifferential equation, and the solution was obtained by an approximate method. The differences between heating and cooling the fluid were examined. The effects of the optical thickness of the fluid, the ratio that determines the relative role of energy transport by conduction to that by radiation, and the emissivity of the duct surfaces on the temperature distribution and the heat transfer characteristics were investigated. An approximate method for calculating the radiant heat flux at the wall is presented, and the accuracy of the approximation tested. (auth)

18123 HEAT TRANSFER CRISIS WITH STEAM-WATER MIXTURES. S. Bertoletti, G. P. Gaspari, C. Lombardi, G. Peterlongo, M. Silvestri, and F. A. Tacconi (CISE, Milan). Energia Nucl. (Milan), 12: 121-72(Mar. 1965).

Experimental results on the heat transfer crisis with steam-water mixtures in heated ducts are reviewed and discussed. Perturbations affecting the normal trend of data are examined first. A discussion of the nature of the phenomenon follows, leading to the selection of natural parameters. Finally a correlation is developed for tubes and generalized for complex geometries. This correlation is checked against data from various origins and is found adequate in a wide range of specific mass flowrates, pressures, and qualities. (auth)

18124 FORCED CONVECTION BURNOUT FOR WATER IN ROD BUNDLES AT HIGH PRESSURES. L. Bernath, P. D. Cohn, and T. J. Sadowski (Atomics International, Canoga Park, Calif.). Intern. J. Heat Mass Transfer, 7: 1385-93(Dec. 1964).

Burnout data from several 12-rod test sections are presented. The influence of power distribution, minimum wall-to-rod separation, and mass flux was investigated. The gross behavior of these test sections was re-analyzed by two computer programs, which allow determination of local coolant conditions in an internally connected, boiling bundle used in the study. The rods were 0.440 in. in diameter and wrapped with 0.022 in. OD hypodermic needle tubing on a 6 in. pitch. Burnout data were obtained at 1200 psia and at mass fluxes from 1 to 5×10^6 lb/hr ft^2. Differences between the heat generation rates in the two interior rods and the remaining ten peripheral rods were 1:1, 1.55:1, and 2.64:1. The minimum wall-to-rod separation was 0.022 in. in four test sections and approximately 0.032 in. in a fifth test section. The gross and local behavior of the test sections were compared to tubular data. Such a comparison indicated that a cold wall effect exists in the peripheral channels, whereas the local behavior in the interior channels agrees closely with the tubular data. (auth)

18125 THE ROLE OF SHEAR AND FORM FORCES IN THE STABILITY OF A DRY PATCH IN TWO-PHASE FILM FLOW. W. Murgatroyd (Queen Mary Coll., London). Intern. J. Heat Mass Transfer, 8: 297-301(Feb. 1965).

The Hartley–Murgatroyd force criterion for the stability of a dry patch was modified as a consequence of experimental results. The role of shear and form forces was examined and it is shown that the experimental results can be explained in a self-consistent manner by assuming that contact angles measured under static conditions are applicable to the flowing film. In the cases analyzed the hitherto neglected shear and form forces appeared to dominate the situation. (auth)

18126 FILM BOILING HEAT TRANSFER AROUND A SPHERE IN FORCED CONVECTION. Kiyosi Kobayasi (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo), 2: 62-7(Feb. 1965).

Film boiling heat transfer around a sphere moving downward in a liquid, was analyzed. The general solution obtained by the theory proposed, developed under certain assumptions, showed that the Nusselt number for predicting

the boiling heat transfer coefficient depends on the Reynolds number, the Prandtl number, the liquid/vapor viscosity ratio, the kinematic viscosity of liquid, the absolute size of sphere, and on another dimensionless number $C_p(\theta_d - \theta_l)/\Delta i$. Results obtained numerically from the general solution were applied as examples to boiling heat transfer for water and sodium, from which it was possible to estimate the heat transfer coefficients for a sphere with boiling. The effect of of radiative heat transfer was also examined. (auth)

18127 CAPACITANCE TYPE VOID METER. Yoshifumi Sakurai, Kimihiro Isozumi, Koichi Mori, and Kenichi Kakizawa (Osaka Univ.). Nippon Genshiryoku Gakkaishi, 7: 64-73(Feb. 1965). (In Japanese)

For studies of two phase flow, it is very important to measure a void fraction; the fraction of air in water flow. Many methods for the void fraction measurement were previously developed. They are, however, considered insufficient in respect to their accuracy, response, handling, and so forth. A void detecting method, which is based on a change of the equivalent dielectric constant, is reported. By this method, the instantaneous void and the local void can be measured with a fast response. Preliminary experiments were carried out with both the simulated void in the form of glass tubes and the real void in an air-water mixture. It is shown that the linearity of this device is good. The basic principle of this void-measuring method is discussed and the real void compared with equivalent circuits, which consist of capacitances and resistances. Experimental results of this device applied to a thermodynamic-hydrodynamic loop, which simulates a nuclear reactor, are shown. (auth)

18128 SOLUTION OF NONSTATIONARY HEAT CONDUCTION EQUATIONS WITH TIME-DEPENDENT ENVIRONMENTAL TEMPERATURE AND TIME-VARIABLE AND VOLUMETRICALLY NONUNIFORMLY DISTRIBUTED HEAT SOURCE. R. Palinski (Euratom, Ispra, Italy). Nukleonik, 6: 289-303(Oct. 1964). (In German)

Fourier's equation of heat conduction with time-dependent ambient temperature and space- and time-dependent source distribution was treated by a Laplace transformation with respect to time and a solution is given in the complex plane. In the given problems the classical method of eigenfunctions is not possible. Diffusion problems described by the same type of equation may be treated in the same manner. The solution in the subsidiary domain was considered for some temperatures of interest at discrete values of the spatial coordinate, and, for the mean temperature, the space dependency was eliminated by an averaging process. When going back to the real domain certain temperature functions were introduced, which satisfied a system of ordinary differential equations with respect to time. Some constants were introduced as parameters. In this way the time-dependent solution for each of the discrete positions was obtained as a solution of a system of ordinary differential equations, where the accuracy could be improved arbitrarily by increasing the number of equations. The problem became thus treatable by means of an analog computer. The accuracy of the method does not depend on the choice of lattice stepwidth. (auth)

18129 HYDRAULIC RESISTANCE AND HEAT TRANSFER IN TURBULENT FLUID FLOW IN A GRID OF BARS. N. I. Buleev, K. N. Polusukhina, and V. K. Pyshin. Teplofiz. Vysokikh Temp., 2: 749-57(1964).

The basic equations of motion and energy of a fluid stream in a bar grid such as the grids used for heat distribution in certain nuclear reactor types were solved, using simplified expressions for the coefficients of turbulent viscosity and temperature conduction. Grid bars arranged in both triangular and square fashion were considered. A means of computing the flow velocity field by considering the flow in a single grid cell was derived. Tabulated values of the velocity vector were given for selected parametric conditions describing grid geometry and liquid state. A relief-type diagram of the relative velocity field is shown for a typical parameter setting. Plots are presented showing the manner of variation of the resistance coefficient with Reynolds number for a variety of grid and flow arrangements. By considering the grids as heat sources, expressions were derived for computing the heat field for grids. Tabulations of temperature field values are presented for both grid arrangements; four parameters are varied in the tabulations. Variations of Nusselt's number with Reynolds number as well as variations of temperature profile along the bar perimeter were compared with experimental model results. (OTS)

18130 NUMERICAL TREATMENT OF TURBULENT FLOWS. Cecil E. Leith (Univ. of California, Livermore). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-2, 5p, $1.00. (CONF-650108-19)

From AIAA 2nd Aerospace Sciences Meeting, New York.

The grid size establishes a lower limit to the scales of motion resolved explicitly in finite difference models of turbulent hydrodynamic flows. Though the initial state of a flow may involve only larger scales of motion nonlinearity leads to motions of smaller scale. This cascading of energy from larger to smaller scales can carry energy out of the resolved scales in a way improperly described by a finite difference scheme. To provide energy removal, a viscosity, ν, depending on the grid scale λ, and on the energy cascade rate ϵ, was previously introduced. If ν depends only on λ and ϵ, dimensional considerations require $\nu = \alpha\epsilon^{1/3}\lambda^{4/3}$ where α is a dimensionless. This ν can be considered as an eddy viscosity diffusing large scale momentum by small scale turbulence. The large scale energy dissipation ϵ is in turn dependent on the large scale deformation rate D. From $\epsilon = \nu D^2$, $\nu = \alpha^{4/3} D\lambda^2$. For one dimension $D = |\Delta u/\Delta x|$, $\lambda = \Delta x$, $\nu = \alpha^{4/3}|\Delta u|\Delta x$ and the viscous stress $q = -\nu(\Delta u/\Delta x) = -\alpha^{4/3}|\Delta u|\Delta u$ has the form of a nonlinear artificial viscosity. (auth)

Materials Testing

18131 (ACF-4) ULTRASONIC TESTING. F. W. Jarrett (ACF Industries, Inc., Albuquerque, N. Mex.). Feb. 15, 1965. Contract AT(29-1)-1352. 17p. (CONF-650109-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Golden Gate Section of the Society for Nondestructive Testing in San Francisco.

A brief survey is presented of the theory, application, equipment, and procedures for ultrasonic inspection. The parameters involved in such inspection are outlined, and its advantages and limitations are described. Criteria are given for successful inspection. (D.L.C.)

18132 (SC-TM-65-31) FORCE-CONTROLLED VIBRATION TESTING. J. V. Otts (Sandia Corp., Albuquerque, N. Mex.). Feb. 1965. Contract AT(29-1)-789. 36p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A discussion is presented of the concept of force-controlled vibration testing, where the input force is controlled into a test system which includes not only the test item but a mass which represents the test item's foundation. The fundamental response characteristics for this type of test are presented and compared with those resulting from motion-input controlled tests. In addition, the methods used in determining the force input spectrum and the magnitude of mass, which simulates the foundation, are considered. (auth)

18133 (UCRL-7739) MEASUREMENT OF PREFERRED ORIENTATION IN BALL BEARINGS BY ULTRASONIC METHODS. H. L. Dunegan (Lawrence Radiation Lab., Univ. of California, Livermore). Feb. 24, 1964. Contract W-7405-eng-48. 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Ultrasonics was used as a nondestructive means of detecting and measuring preferred orientation in steel ball bearings. Most of the bearings tested exhibited preferred orientation in the direction of the original axis of the rod from which they were made. (D.L.C.)

Protective Structures

18134 (NP-14804) THE BEHAVIOR OF SHALLOW-BURIED CYLINDERS. A SYNTHESIS AND EXTENSION OF CONTEMPORARY KNOWLEDGE. Technical Report R-344. J. R. Allgood (Naval Civil Engineering Lab., Port Hueneme, Calif.). Jan. 8, 1965. 74p. $2.00(CFSTI).

The available information pertinent to the behavior of shallow-buried cylinders is synthesized and extended to gain a better understanding of its use for improving the design of underground shelters. The theoretical and experimental data are examined to define the areas in which further research is needed. A failure plane analysis yields (1) the minimum depth of cover required for all of the surface load to be carried by arching, (2) the maximum percentage of surface load which can be carried by arching for any lesser depth, and (3) the relative deformation between the structure and the free field required to develop the maximum possible arching. For a shallow-buried cylinder in a uniform granular soil field, the net arching is shown to be essentially zero. Because the net arching across the structure is zero, the effective load on the structure tending to induce failure is the surface pressure. Consideration is given to the possibilities of elastic and inelastic buckling in the roof caving and local transitional buckling modes. Evidence is cited which indicates that for depths of cover sufficient to provide radiation protection, and for relatively thin-walled cylinders, failure will normally be in the inelastic transitional mode where a local buckle develops at or near the bottom of the cylinder. (auth)

Vacuum Engineering

Refer also to abstract 17919.

18135 (IPP-4/16) ÜBERWACHUNGS- UND STEUERGERÄT FÜR VAKUUMPUMPSTÄNDE. (Control System for Vacuum Pumping Stations). H. Haeglsperger (Institut für Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1964. 11p. Dep.(mn).

Vacuum pumping stations require control during operation, especially over long running times. Also appropriate corrective measures must be taken whenever pumping is interrupted. A device is described with which it is possible to control, and automatically regulate, everything necessary for a faultless pumping operation, as well as for baking out on ultrahigh-vacuum installations. (auth)

18136 (UCRL-7830) MECHANICAL MOTION IN VACUUM. Thomas H. Batzer (Lawrence Radiation Lab., Univ. of California, Livermore). Apr, 15, 1964. Contract W-7405-eng-48. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Mechanical motion in vacuum is described in terms of how it is achieved, its purpose, the effect of vacuum on the mechanism, and the effect of the mechanism on the vacuum. A vacuum environment permits certain processes to proceed that might otherwise be impracticable. Mechanical motion in vacuum processing is often needed. The seals and motion mechanisms, including lubrication, must not adversely affect the permissive vacuum environment. Conversely, in the case of very low pressure ($<10^{-9}$ torr) the motion mechanism needs protection from the vacuum. Based on these considerations, some current means and methods of providing mechanical motion in vacuum are discussed. (auth)

GEOLOGY AND MINERALOGY

General

Refer also to abstract 19429.

18137 (EUR-2110.e) A STUDY OF SOME NIOBIUM-BEARING MINERALS OF THE LUESHE CARBONATITE DEPOSIT (KIVU, REPUBLIC OF CONGO). L. Van Wambeke (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center and Hollandse Metallurgische Industrie Billiton N. V., Arnhem (Netherlands)). 1965. 31p. (CONF-641212-1). Dep.(mn).

From Symposium on the Mineralogy of Carbonatite and Alkaline Ultrabasic Rocks, New Delhi, India.

New data are given on the mineralogy and on the geochemistry of some niobium-bearing minerals from the Lueshe carbonatite deposit: pyrochlore, hydrated K-Sr pyrochlore, fersmite, columbite, lueshite, aegirite, zircon, and a probably new iron titanium mineral of formula $(Fe^{II},Mn,Mg)_4Fe_2^{III}Ti_6O_{19}$. In the three last minerals, Nb and Ta occur as accessory elements. Ba-goyazite was also found as mineral inclusions in some pyrochlores. The new hydrated K-Sr pyrochlore shows a large deficit of the elements in the A-positions and a parameter value of about 10.58 Å. Its origin is discussed. Two types of fersmites (I and II) were found: the first is associated with the columbitization of pyrochlore, the second replaces columbite and occurs in a later carbonatitic stage. Physical properties, x-ray data, and a chemical analysis are given for the probably new iron titanium mineral. The geochemical distribution of Nb, Ta, rare earths, U, Th, and other elements was studied in all minerals investigated. The Nb–Ta ratio widely varies and is much higher in the niobium minerals whereas the lowest values were found in the Nb-containing minerals. The Ce group dominates in the pyrochlores and in lueshite and the Y group in the fersmite II and in the zircon. The Ca-niobates are generally richer in U whereas Th is predominant in zircon and especially in lueshite. The processes of the columbitization of pyrochlore and the fersmitization of columbite are described. From these processes it is indicated that the carbonatitic differentiation is characterized in a late stage by an enrichment with Ta, Fe, Mn, V, and rare earths. (auth)

18138 FIXATION OF NITROGEN BY AURORA AND ITS CONTRIBUTION TO THE NITROGEN BALANCE OF THE EARTH. A. T. Wilson and D. A. House (Victoria Univ. of Wellington, New Zealand). Nature, 205: 793-4 (Feb. 20, 1965).

It is generally believed that the dissipation of energy in the upper atmosphere of the Earth by such geophysical phenomena as aurora, air glow, and particulate bombardment leads to the formation of chemical species among which are oxides of nitrogen or their corresponding charge species. If these chemical species could reach the surface of the Earth they would contribute nitrate and nitrite to the biosphere. The magnitude of this effect was estimated by the chemical analysis of snow at the South Pole. It was concluded that the annual infall of nitrogen as nitrate and nitrite at the South Pole due to geophysical phenomena in the upper atmosphere is less than, or equal to, 0.005 kg/hectare (0.0045 lb/acre). (P.C.H.)

Natural Radioactivity and Fallout

Refer also to abstracts 17792 and 18225.

18139 (AWRE-O-20/65) THE DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION OF THE PARTICULATE MATERIAL COLLECTED DURING THE DOUBLE TRACKS AND CLEAN SLATE 1 EVENTS OF OPERATION ROLLER COASTER. J. P. Friend (Isotopes, Inc., Westwood, N. J.) and D. M. C. Thomas (Atomic Weapons Research Establishment, Aldermaston (England)). Feb. 1965. 34p. Dep.(mn); $1.00(BIS) 5s.0d.(HMSO).

The overall size-plutonium distributions for Double Tracks and Clean Slate 1 were determined and found to be the same within experimental error. The distributions are not log-normal, and the contradictory estimates of the geometric standard deviation in TG57 from impactors and the deposition model are explained on a rational basis. (auth)

18140 (CEA-R-2625) ETUDE EXPERIMENTALE DE LA CONTAMINATION RADIOACTIVE PAR L'EAU D'IRRIGATION DE CERTAINES PLANTES CULTIVEES. (Experimental Study of the Radioactive Contamination of Certain Cultivated Plants by Irrigation Water). (Institut National de la Recherche Agronomique, Paris (France) and Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre d'Études Nucléaires). Nov. 1964. 21p. Dep.(mn).

Results are reported from studies on the uptake of ^{137}Cs and ^{90}Sr by cultivated plants from irrigation water. Data are presented on the ratio between the amount of radioelement in a kilogram of the harvested vegetable product to the amount of radioelement present in a liter of irrigation water. The influence of soil type mode of irrigation, and growth habits of the plants on uptake of the radioisotopes are discussed. The vegetables studied included carrots, cabbage, cauliflower, spinach, leek, green beans, salad greens, tomatoes, and potato tubers. (C.H.)

18141 (CEA-R-2627) MESURES QUOTIDIENNES DE LA RADIOACTIVITE ATMOSPHERIQUE A LONGUE PERIODE SUR LES PRINCIPAUX SITES NUCLEAIRES FRANCAIS EN 1963. (Daily Measurements of the Long-Lived Atmospheric Radioactivity Present on the Main French Nuclear Sites in 1963). André Doury and Claude Caput (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Jan. 1965. 43p. Dep.(mn).

This report follows on to the CEA report No. 2397 and is designed primarily to provide a detailed and convenient recapitulation of the main measurement results obtained during the continuous supervision of French nuclear sites. The results published correspond to the radioactive constituent of the atmosphere which should be the most affected by any waste coming from an installation (fission products) Up to the present, only test explosions can reasonably be held responsible for atmosphere pollution whose level nevertheless remains very low with respect to permissible norms. (auth)

18142 (CEX-63.11) MOBILE RADIOLOGICAL MEASURING UNIT: DESCRIPTION AND OPERATING INFORMATION. Z. G. Burson, R. L. Summers, and J. T. Brashears (Edgerton, Germeshausen and Grier, Inc., Boston, Mass., Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.; and Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Aug. 9, 1963. Contract AT (29-1)-1183. 60p. Dep.; $1.00(cy), 2(mn) CFSTI.

A hydraulically pumped radiation source system is described for simulating fallout. Detailed operating information, emergency procedures, and health physics operating regulations are given. (D.L.C.)

18143 (EUR-1838.d.f.i.n) RADIOACTIVE CONTAMINATION OF MILK IN THE COUNTRIES OF THE COMMUNITY IN 1962. (European Atomic Energy Community). Feb. 1965. 51p. Dep.(mn).

In German, French, Italian, and Dutch.

Results are reported from measurements of radioactive contamination of milk in the European Atomic Energy Community countries in 1962. The data relate to the radionuclides I-131, Sr-90, Sr-89, and Cs-137. An estimate is given of the irradiation dose resulting from milk consump-

tion. Tables and graphs illustrate the pattern followed in the course of the year. Certain special areas are dealt with separately. The average contamination for the Community is calculated and compared with that for the U. S. and Canada. (auth)

18144 (HASL-156) THE HASL SURFACE AIR SAMPLING PROGRAM SUMMARY REPORT FOR 1963. Herbert L. Volchok (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Jan. 15, 1965. 73p. Dep.; $1.75(cy), 2(mn) CFSTI.

This report covers the first year of operation of the Surface Air Sampling Program at the Health and Safety Laboratory. The data developed in 1963 and a description of the sampling sites, sampling equipment, and methodology are presented. During 1963 over 1,700 air filter samples and 400 samples of precipitation were assayed for gross gamma concentration, fission products, and neutron activation products. The results of these analyses indicate that in Northern Hemispheric surface air in 1963, the well documented spring peak occurred and that in general the air was well mixed with respect to fission products. Through most of the year the air of the Southerm Hemisphere was not as thoroughly mixed. The trends of various radionuclide concentrations and radionuclide ratios suggest that a substantial portion of the nuclear debris detected at ground level in the Southern Hemisphere came across the Equator from the troposphere of the Northern Hemisphere. (auth)

18145 (ISS-64/38) SULLE RICADUTE RADIOATTIVE CONSEGUENTI ALLE ESPLOSIONI NUCLEARI. (Fallout of Radioactive Debris Following Nuclear Explosions). G. De Florio (Istituto Superiore di Sanitá, Rome (Italy). Laboratori di Fisica). Nov. 14, 1964. 39p. Dep.(mn).

A brief description is presented of the methods of collection and examination of radioactive fallout particles. A summary of formation processes is included and the radiochemical composition of debris is discussed in connection with the fractionation process. (auth)

18146 (TEI-858) SUBSURFACE MEASUREMENTS OF NATURAL GAMMA RADIOACTIVITY, NEVADA TEST SITE AND VICINITY, NYE, LINCOLN, AND CLARK COUNTIES, NEVADA. Carl M. Bunker (Geological Survey, Washington, D. C.). Mar. 1965. 74p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The natural radioactivity of various rock types was measured semiquantitatively by tunnel surveys with portable scintillation-type detectors and by gamma-ray logging of drill holes and wells with Geiger-Mueller detectors. Field studies were made from 1957 through 1962. Radiation intensities ranged from 0.001 mR per hr in dolomite and dolomitic marble to 0.045 mR per hr in granodiorite. Intensity ranges were virtually the same in dacite, granodiorite, rhyolite, and tuff; these rock types were significantly more radioactive than dolomite and basalt. Changes in radioactivity could in places be related to subunits in the tuff of the Piapi Canyon Group and Indian Trail Formation. The range in radiation intensity was determined by wall surveys to be 0.014–0.024 mR per hr. Chemical analyses of tuff in these stratigraphic units indicated low uranium content, and as much as 7 percent potassium content. (auth)

18147 (UCRL-12165-T) THE LRL PARTICLE ANALYSIS PROGRAM. Robert E. Heft and James S. Kahn (Lawrence Radiation Lab., Univ. of California, Livermore). Nov. 1, 1964. Contract W-7405-eng-48. 13p. (CONF-765-9). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 2nd Conference on Radioactive Fallout from Nuclear Weapons Tests, Germantown, Md., Nov. 1964.

A program has been established for the purpose of determining the distribution of individual radionuclides in particulate radioactive material. Particulate samples collected at their point of origin and selected on the basis of the degree to which they represent the true particle population are separated into groups and analyzed on a totality basis. The overall analytical program is described and an example is given of the initial information produced in a particle group separation performed on a filter sample from the SEDAN event. (auth)

18148 (UWFL-87) RADIONUCLIDE CONTENT OF FOODSTUFFS COLLECTED AT CHRISTMAS ISLAND AND AT OTHER ISLANDS OF THE CENTRAL PACIFIC DURING OPERATION DOMINIC, 1962. Ralph F. Palumbo (Washington Univ., Seattle. Lab. of Radiation Biology). Aug. 1, 1963. Contract AT(45-1)-1385. 38p. Dep.(mn); $2.00 (cy), 2(mn) CFSTI.

The results of the analyses made of the samples of food, soil, and plant leaves collected during Operation Dominic indicate that small amounts of radionuclides originating from the test series at Christmas Island were deposited on Christmas Island as well as on several islands to the north, south, and west during the period April 26 to July 25, 1962. The predominant short-lived radionuclides detected in these samples were $^{95}Zr-^{95}Nb$, ^{103}Ru, $^{141,144}Ce$, and $^{140}Ba-^{140}La$. Iodine-131 was detected in only a few samples. The long-lived fallout radionuclides detected in these samples were ^{65}Zn, ^{137}Cs, ^{60}Co, ^{57}Co, and ^{90}Sr. Potassium-40, a naturally occurring radionuclide, was present in most samples and was the single greatest contributor to the total radioactivity of the samples. A major portion of the samples collected at these islands did not contain activity which was significantly above the levels detectable by the methods used in this study. The remainder of the samples contained activity at levels usually less than one picocurie per gram of wet weight. The levels of radioactivity present in the total diet at all islands were too low to produce a health hazard to the people residing on these islands. (auth)

18149 (JPRS-28558) STRONTIUM-90 IN THE WATERS OF THE PACIFIC OCEAN. (SECOND REPORT—SURFACE WATERS OF THE CENTRAL PORTION, 1961). N. I. Popov, S. A. Patin, R. I. Polevoy, and V. A. Konnov. Translated from Okeanologiya, 4: 1026-9(1964). 5p. (TT-65-30241). $1.00(CFSTI).

Quantitative data are presented on the ^{90}Sr content in Pacific Ocean waters to the south of the equator sampled from Aug. through Dec. 1961. Analysis of the data indicate that the ^{90}Sr content of water south of the equator is somewhat lower than that of waters of the northern hemisphere. It is pointed out that the sampling period was preceded by several years in which there were no nuclear tests. The effects of horizontal turbulent diffusion and of processes of vertical mixing of ocean waters on the equalization of ^{90}Sr concentration in surface waters of the Pacific Ocean are discussed briefly. (C.H.)

18150 NATURAL RADIOELEMENT CONTENT (U^{nat}, Th^{nat}, ^{40}K, ^{226}Ra, ^{222}Rn, AND ^{210}Pb) OF THE THERMAL WATERS OF PLOMBIERES-LES-BAINS. P. Kayser and A. Meunier (Faculte de Medecine, Nancy). Ann. Pharm. Franc., 22: 365-72(May 1964). (In French)

The natural radioelements of the mineral waters of Plombieres (Vosges) are estimated. U was determined by fluorimetry in fused NaF after removal of interfering ions; it was shown that Zr, Th, and Fe did not interfere. Th was determined colorimetrically using thorin; the method developed has maximum sensitivity of 2 μg Th. Rare earths, U, Zr, and Na silicate did not interfere. The invariant content of ^{40}K in natural K allowed the use of conventional flame spectrophotometry for K. The determination of ^{226}Ra was based on ^{222}Rn, so that the determinations of these two radioisotopes were similar (counting of ^{222}Rn activity). ^{210}Pb was determined by its daughter ^{210}Bi. Nine water samples were determined in triplicate. ^{226}Ra had a range of <2.5 to 18 pC/l; ^{222}Rn, 1192 to 17794 pC/l; U, 0.2 to 4.2 μg/l; Th, <2 μg/l; ^{210}Pb, <1.0 to 7 pC/l; and ^{40}K, 1.1 to 6.5 pC/l (error limits from 4 to 63%). It was concluded that the relation between ^{222}Rn content and therapeutic activity should be studied. It is recommended that the Rn be removed before these waters are bottled as table water. (BBB)

18151 A MODIFIED TECHNIQUE FOR TRACE LEAD GAS SOURCE MASS SPECTROMETRY. A. B. L. Whittles

and W. F. Slawson (Univ. of British Columbia, Vancouver). Geochim. Cosmochim. Acta, 29: 142-3(Feb. 1965).

A technique for trace lead gas-source mass spectrometry was modified to extend the preparation of $Pb(CH_3)_4$ to samples containing at least one order of magnitude less lead than reported previously. The lead is distilled from a sample, in the presence of a flow of hydrogen, and forms a mirror on the inside of a quartz tube. Free methyl radicals are reacted with the lead mirror to form tetramethyl lead. By-products from this reaction are partially distilled from the tetramethyl lead sample. Samples estimated to contain 10 ppm lead were studied and lead isotope abundances were determined with a precision of ±0.4%. (M.C.G.)

18152 ISOTOPIC COMPOSITION AND ORIGIN OF VOLCANIC SULFUR. V. I. Vinogradov (Academy of Sciences, Moscow). Geol. Rudn. Mestorozhd., 6: No. 3, 7-15(1964). (In Russian)

Samples of SO_2 gas from three volcanoes were found to have ^{34}S enrichments of 1.90, 2.77, and 1.90, respectively. The predominant part of the sulfur was not recent in origin, indicating that the gas formed at great depths. (M.C.G.)

18153 RADIONUCLIDES IN MILK: DETERMINATION OF PICOCURIE CONCENTRATIONS OF IODINE-131 IN MILK. Bernd Kahn (Robert A. Taft Sanitary Engineering Center, Cincinnati). J. Agr. Food Chem., 13: 21-4(Jan.-Feb. 1965).

A rapid procedure for sample preparation, in which anion exchange resins are used to separate ^{131}I from the other medium- and long-lived fission products in milk, is described. In this procedure the iodine is made available for β counting after separation from the resin. It is eluted from the resin, precipitated as silver iodide, washed to remove silver chloride and organic impurities, and then β-counted. Five ml of Dowex 1-X8 (50- to 100-mesh) strong-base anion exchange resin in chloride form is used. Iodide is eluted from resin with 75 ml of 2M sodium perchlorate. Iodine-131 is then precipitated from the perchlorate eluate, only a slight excess of silver nitrate precipitant being added to minimize the amount of contaminating silver chloride. When the purified silver iodide is then filtered, washed, dried, weighed, and counted, the average yield is 89%. The entire analysis in quadruplicate can be performed in 4.5 hr. The minimum detectable level is 1 and 0.3 pC/l for 1-hr and overnight β counting, respectively. Separation of ^{131}I from other fallout nuclides by this procedure was tested. The initial added concentration of the tracers was 200,000 pC/l for ^{137}Cs and between 300,000 and 400,000 pC/l for ^{85}Sr, ^{140}Ba, and ^{140}La. Less than 5 pC of the tracers remained in the precipitate, demonstrating a decontamination factor of 40,000 or greater. Since these fission products are rarely found in concentrations above 1000 pC/l, this decontamination is sufficient. Satisfactory separation from the 1300 pC of naturally occurring ^{40}K/l of milk was indicated by the absence of significant radioactivity in the precipitate. In addition to its application in detecting ^{131}I in the 1 pC/l range, this procedure has been used for simplifying the routine milk-network analysis of ^{131}I and for rapidly estimating ^{131}I in milk at concentrations significant for radiological health action (above 100 pC/l). (BBB)

18154 DISTRIBUTION OF RADIOACTIVE RAINOUT IN CONVECTIVE RAINFALL. F. A. Huff and G. E. Stout (Illinois State Water Survey, Urbana). J. Appl. Meteorol., 3: 707-17(Dec. 1964). (COO-1199-4)

An investigation was made of the distribution characteristics of radioactive rainout in convective rainstorms through use of data from 29 storms collected on a network of automatic rainwater samplers in central Illinois during spring and summer 1963. Storm profiles of the concentration of radioactive rainout were correlated with rainfall factors and types of synoptic weather. It was found that the storm profiles of rainout could be grouped into four major and three minor types in which the major types accounted for 90 per cent of the cases and the most frequent type occurred 45 per cent of the time. Tentative explanations of the atmospheric conditions under which the major types prevail are presented. (auth)

18155 VARIATIONS IN THE O^{18}/O^{16} AND C^{13}/C^{12} RATIOS OF DIAGENETICALLY ALTERED LIMESTONES IN THE BERMUDA ISLANDS. M. Grant Gross (California Inst. of Tech., Pasadena). J. Geol., 72: 170-94(Mar. 1964).

Marine and eolian Pleistocene sediments in the Bermuda Islands are composed largely of fragments of mollusks, Foraminifera, lithothamnoid algae, and Halimeda. The Pleistocene sediments range from unconsolidated carbonate sands to well-consolidated limestones. Recent carbonate sediments and major sediment-contributing organisms (except Halimeda) had similar $^{18}O/^{16}O$ and $^{13}C/^{12}C$ ratios, which were distinctly different from the $^{18}O/^{16}O$ and $^{13}C/^{12}C$ ratios observed in the stalactites, soil bases, and secondary calcites from the limestones. Precipitation of secondary calcite in the limestones and alteration of the constituent grains caused the $^{18}O/^{16}O$ and $^{13}C/^{12}C$ ratios of the limestones to approach the values observed in stalactites and soil bases. Secondary calcites, precipitated from fresh water on the Bermuda Islands, had $^{18}O/^{16}O$ ratios, which were controlled primarily by the average $^{18}O/^{16}O$ ratio of the rain water on the island. The $^{13}C/^{12}C$ ratios of the secondary calcites were controlled by the amount of carbon dioxide derived from the soil zone, which was mixed with carbon derived from solution of the limestones through which the water passed. Some of the limestones from the intertidal or surf-spray zone had $^{18}O/^{16}O$ and $^{13}C/^{12}C$ ratios, which were distinctly different from the majority of the well-consolidated limestones. These limestones possibly were lithified by cement precipitated from fresh water, which was subjected to evaporation and to exchange of carbon with atmospheric carbon dioxide. (auth)

18156 THIN ATMOSPHERIC LAYERS OF RADIOACTIVE DEBRIS DURING SEPTEMBER 1961 AND 1962. K. A. Anderson (Univ. of California, Berkeley). J. Geophys. Res., 70: 1139-53(Mar. 1, 1965).

During series of balloon flights made in September 1961 and 1962, layers of radioactive debris from nuclear weapons tests were observed on thirteen separate occasions. The layers of debris were thin, ranging from 400 to 1200 m. Most of the layers occurred in the stratosphere, but on two occasions they were found in the troposphere. (auth)

18157 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME V, NUMBER 11. (Public Health Service, Washington, D. C.). Nov. 1964. 58p. $0.50(GPO).

Separate abstracts were prepared for eight sections of this report. Data are also included on the β activity from fallout fission products in samples of air and precipitation collected at sampling stations in the U. S., Canada, and Pan America during July 1964. (C.H.)

For abstracts of individual sections see: 18158, 18159, 18160, 18161, 18162, 18163, 18164, and 18165.

18158 EVALUATION OF RADIATION SURVEILLANCE NETWORK EXTERNAL GAMMA RADIATION DATA, 1959–1963. Warren W. Church. Radiol. Health Data, 5: 531-4 (Nov. 1964).

The Radiation Surveillance Network was established in 1956 to provide information on gross β activities in surface air and in precipitation throughout the U. S. Daily measurements of external γ activity were also made at each of the 74 sampling stations. Data on monthly averages are summarized for 1959 through 1962. (C.H.)

18159 MILK SURVEILLANCE. Radiol. Health Data, 5: 535-45(Nov. 1964).

The Public Health Service pasteurized milk surveillance program consists of 63 stations with at least one located in every state, the Canal Zone, and Puerto Rico. Data are also received from the Canadian milk sampling program. Analytical and sampling procedures are described. Data are presented on the ^{137}Cs and ^{90}Sr content of milk samples collected during July, 1964. (C.H.)

18160 MOVING ANNUAL AVERAGE RADIONUCLIDE CONCENTRATIONS IN PASTEURIZED MILK, AUGUST 1963–JULY 1964. Radiol. Health Data, 5: 545-7(Nov. 1964).

Data are presented on the annual average content of ^{137}Cs, ^{89}Sr, and ^{90}Sr in pasteurized milk samples collected in the U. S. from July 1963 through June 1964. (C.H.)

18161 STRONTIUM-90 CONTENT OF HUMAN FOOD AND ANIMAL FEED IN 1962 AND 1963. Radiol. Health Data, 5: 547-51(Nov. 1964).

Data are presented on the ^{90}Sr content in human food and animal feeds harvested during 1962 and 1963. (C.H.)

18162 GROSS RADIOACTIVITY IN SURFACE WATERS OF THE UNITED STATES, MAY 1964. Radiol. Health Data, 5: 553-6(Nov. 1964).

Data are presented on the gross α and β radioactivity and ^{90}Sr content in samples of surface waters collected in the U. S. during May 1964. (C.H.)

18163 RADIOACTIVITY IN WATERS AND SEDIMENTS OF THE COLORADO RIVER BASIN, 1950–1963. D. T. Wruble, S. D. Shearer, D. E. Rushing, and C. E. Sponagle. Radiol. Health Data, 5: 557-67(Nov. 1964).

Data are presented on the radioactivity in samples of waters and sediments of the Colorado River Basin collected from 1950 through 1963. The contributions of natural radioactivity and radioactivity due to uranium mining and milling activities are discussed. Data are presented on gross α radioactivity, gross β radioactivity, 226 Ra, U, ^{210}Pb, and ^{210}Po in samples of water and sediments. (C.H.)

18164 RADIONUCLIDE ANALYSES OF COAST GUARD WATER SUPPLIES, JANUARY–DECEMBER 1963. Radiol. Health Data, 5: 568-9(Nov. 1964).

The water supplies of 7 Coast Guard Stations in Alaska were analyzed for gross α activity, gross β activity, ^{90}Sr, ^{131}I, ^{140}Ba, ^{103}Ru–^{106}Ru, and ^{95}Zr–^{95}Nb. Data are presented for samples collected during 1963. (C.H.)

18165 ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS. Radiol. Health Data, 5: 571-7(Nov. 1964).

Data are presented on environmental levels of radioactivity at the Bettis Atomic Power Laboratory, Mound Laboratory, and Shippingport Atomic Power Station, from July through Dec. 1963. During Oct. 1961, 4 nuclear tests were announced by the USAEC and one nuclear test was announced by Communist China. Data on the 4 underground U. S. tests are summarized. Preliminary analysis of fallout from the Chinese explosion indicates it involved a low-yield fission device employing ^{235}U. (C.H.)

18166 VARIATIONS IN THE ISOTOPE RATIO $^{39}K/^{41}K$ IN NATURAL POTASSIUM. M. Sh. Kaviladze and I. V. Abashidze. Soobshch. Akad. Nauk Gruz. SSR, 35: 67-74 (1964). (In Russian)

An ion source is described, which has an ionization surface for the simultaneous analysis of 3 samples of the solid, one of which is a standard. This source was used with a mass spectrometer to analyze 22 different samples of rocks and minerals in order to determine the $^{39}K/^{41}K$ ratio. The sites, geological age, argon age (for some samples), and the isotopic ratio are recorded in tables. Determinations with the same sample on all three ionization surfaces showed that the average results do not vary from surface to surface by more than 0.2 to 0.3%. The variation in the ratio in the samples studied was ~0.25%. (M.C.G.)

18167 SOME QUANTITATIVE PROPERTIES OF A FALLOUT MODEL. J. Prawitz (Research Inst. of National Defence, Stockholm). Tellus, 16: 472-80(Nov. 1964).

According to a suggested model of the vertical transport of small particles in the upper air, the concentration and the accumulation on the ground after an instantaneous injection were calculated for the case of particles with a density of 5 g/cm^3 and with sizes up to 0.005 mm. Equations and parameters are presented in detail. (auth)

18168 CONTRIBUTION TO THE STUDY OF THE LEVEL OF NATURAL RADIONUCLIDES OF MINERAL WATERS OF MONDORF-LES-BAINS AND PLOMBIERES. P. Kayser. Thesis, Nancy, Faculte de Pharmacie, 1962.

18169 CHEMICAL QUALITY OF WATER. BROOKHAVEN NATIONAL LABORATORY AND VICINITY, SUFFOLK COUNTY, NEW YORK. Wallace de Laguna (Geological Survey, Washington, D. C.). 1964. Geological Survey Bulletin 1156-D. 77p. (GPO)

Results of chemical analyses (including radioactivity) of about 300 water samples collected from wells, lakes, and rivers in the vicinity of Brookhaven National Laboratory during the period 1948 to 53 are tabulated and interpreted. The date presented are intended to be used as norms for problems of water contamination which may arise in the future. Fourteen samples of ground water contained a very low level of radioactivity, the maximum being 5×10^{-14} C/ml, which probably represented natural activity in the water. Beta activity was found in 55 samples of surface water (maximum, 3.7×10^{-13} C/ml. This relatively large number of radioactive samples was partly due to the fact that samples were collected in October 1951 when fallout from atom bomb tests in Nevada first made its appearance in the area. One significant result of the study was the identification of widespread groundwater contamination, marked by high nitrate content, from the leaching of fertilizer in the intensively farmed areas, and a similar local contamination of groundwater by cesspools. (auth)

Site Survey and Selection

Refer also to abstract 19342.

18170 TURBULENCE STATISTICS AT DOUGLAS POINT. R. E. Munn. J. Appl. Meteorol., 3: 771-9(Dec. 1964).

The standard deviations of azimuth and elevation angle were determined at Douglas Point, Ontario (at a height of 82 ft), and at Paisley, ten miles distant (at a height of 50 ft), on about 500 occasions during the early summer of 1962. The data were classified according to wind speed, wind direction, and time of day. Individual standard deviations may be affected by intermittency and non-stationarity. However, median values display well-defined trends. Since the trends are similar at two locations with differing terrains, the results may have qualitative applicability to other areas. There is a diurnal cycle with largest median standard deviations during the day. As the wind speed increases, the direction becomes steadier with one exception; at night, the median standard deviations for short presmoothing times increase when the wind rises above 10 mph. Because of local obstructions, wind direction has a large effect on the magnitude of the standard deviations. A sample of about 80 concurrent observations shows no close association between standard deviations at Douglas Point and at Paisley. (auth)

Techniques and Equipment

Refer also to abstracts 17839 and 18231.

18171 (AD-422423) A BIBLIOGRAPHY OF SEISMOLOGY FOR THE VELA UNIFORM PROGRAM. Report of VESIAC. Addendum No. 5. (Michigan. Univ., Ann Arbor. Acoustics and Seismics Lab.). Oct. 1963. 158p. $11.00(CFSTI).

This fifth addendum lists authors and titles and gives abstracts for several hundred publications on seismology and the detection of underground explosions. The list of authors and titles is arranged by areas of the VELA UNIFORM Program of the Advanced Research Projects Agency. The author's names are cross-referenced and variant spellings are indicated. (auth)

18172 (NP-14809) ARRAY RESEARCH BASIC THEORY OF PROBABILISTIC PROCESSING. Special Re-

port No. 4. John Burg (Texas Instruments Inc., Dallas. Science Services Div.). Dec. 3, 1964. Contract AF33(657)-12747. 51p.

The use of probabilistic processing on an array of seismometers, with the aim of detecting earthquake or underground nuclear blast signals in the presence of ambient seismic noise, is investigated. The investigation is principally concerned with the processing of Gaussian multichannel stationary time series. The theoretical goal is a continuous determination of the probability that the multichannel-array data represent signal plus seismic noise, as opposed to seismic noise alone. Analog techniques for implementing the processing are outlined. (T.F.H.)

18173 (POR-1809) LONG RANGE AIR-BLAST MEASUREMENTS AND INTERPRETATIONS. J. W. Reed (Sandia Corp., Albuquerque, N. Mex.). May 1962. Project 1.1a [of] PROJECT DANNY BOY. 36p. (WT-1809). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Low-pressure air blast was measured for Project Danny Boy out to 240 km, mainly in order to find the attenuation caused by the hard rock environment of the shot and to compare results with both nuclear and HE shots in other media. Nine microbarograph stations were operated. Various operational difficulties reduced the number of signal correlation points. Airblast pressures, both close-in and far-out, were appreciably smaller than expected from experience with underground HE shots. Transmission factors will not be calculated until final radiochemical yield values for the shot are obtained. (auth)

18174 (TID-21630) PROJECT DRIBBLE. (Nevada Operations Office (AEC), Las Vegas). Aug. 1, 1964. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Background information is presented on the Project Dribble, a planned series of three underground nuclear detonations in the Tatum Salt Dome in Mississippi. The objectives of the project are outlined, and the preparations for the first detonation (Salmon) are described. The precautions to be taken to assure the safety of the people living nearby are also described. (D.L.C.)

18175 (VESIAC-4260) GNOME SEISMOGRAM ALBUM. (Michigan Univ., Ann Arbor. Acoustics and Seismics Lab.). Dec. 1962. Contract SD-78. 141p.

A compilation is presented of GNOME seismograms, collected from stations in the United States (including Alaska), Canada, Sweden, and Finland. The records were choser as typical for different geographic regions of the northern hemisphere. Information about the seismograms, e.g., station and instrument data, are included when available. Basically historical and informative, the report shows the great geographical distances at which the GNOME seismic signal was recorded. (auth)

18176 (VESIAC-4992-VU) DIFFERENTIATION OF EARTHQUAKES AND UNDERGROUND NUCLEAR EXPLOSIONS ON THE BASIS OF AMPLITUDE CHARACTERISTICS. David E. Willis, John DeNoyer, Henry Pollack, and James T. Wilson (Michigan. Univ., Ann Arbor. Acoustics and Seismics Lab.). Mar. 22, 1963. 16p.

The particle velocity ratios of the maximum shear-surface waves to maximum compressional waves were determined for a large number of earthquakes recorded over a wide geographic range. These results are compared with similar type data for underground nuclear detonations recorded in the United States. It was found that this technique could be used as a diagnostic aid to distinguish between these two type sources at distances less than 1000 km. (auth)

18177 (VUP-2101) MEASUREMENT OF CLOSE-IN EARTH MOTION. L. M. Swift (Stanford Research Inst., Menlo Park, Calif.). Mar. 15, 1962. Project 1.2 [of] NOUGAT SERIES—HARD HAT EVENT. 50p. (VESIAC-5358VU). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The primary measurements of Project 1.2 on Shot Hard Hat (predicted ~5 kt, detonated in granite 950 feet below the surface) were close-in earth motion from the surface to a depth of 2000 feet and from surface zero to a horizontal radius of 3000 feet. In addition a few channels of instrumentation were devoted to an attempt to measure cavity pressure. Several types of instrumental and operational troubles caused failure of a number of channels and only partial data to be obtained from some of the remaining. The data obtained are expected to give definitive information on much of the close-in earth motion, but much of the data expected on the long-period motion does not appear to have been obtained. A study of the peak values of measured acceleration, velocity, displacement, and strain shows that these values were mostly within a range of 2:1 from the predicted values, usually larger than predictions. In comparison with Shots Rainier and Antler, which were in the tuff of the Rainier mesa, all peak values from Hard Hat were noticeably greater, especially the acceleration peaks. Widespread spalling of the near-surface formation is evident from the surface motion but no information on the depth of spalling has been derived. (auth)

18178 (OTS-64-11459/2(p.31-8)) RADIOACTIVE TRACERS IN STUDYING BED LOAD MOVEMENTS. Vojislav Vukmirovic, Anton Filip, Petar Todorovic, and Radivoje Vukotic. Translated from Saopstenja Inst. Vodoprivredu "Jaroslav Cerni," 9: No. 31, 31-8(1964).

Results are reported of measurements made on the Velika Morava (near Cuprija) and the Danube rivers in 1962 and 1963. Sand surface-labeled with ^{51}Cr was used. The results show that the tracer method can be used to determine the bed load velocity, the limit of the bed load movement, and the quantity of the bed load. (D.L.C.)

18179 LONG PERIOD SEISMIC WAVES FROM LARGE, NEAR-SURFACE NUCLEAR EXPLOSIONS. Paul W. Pomeroy (Columbia Univ., New York). Bull. Seismol. Soc. Am., 53: 109-49(Jan. 1963). (AFCRL-63-293).

Seismic surface waves of the fundamental Rayleigh mode were well recorded from US and USSR test explosions of 1958. In addition, Love waves were recorded at Hong Kong and Agra, India, and waves of the first shear mode were recorded at Uppsala, Sweden and Agra. Oceanic Rayleigh wave phase velocities were derived in the period range of 15 to 40 sec. The ratio of seismic energy to yield indicates the USSR explosions were detonated at altitudes higher than the US shots of 1958. The Fourier amplitude spectra of the surface wave trains is generally single-peaked; but along short, continental paths, a second peak at 10 to 13 seconds is observed. (auth)

18180 ON THE SIMULTANEOUS ORIGIN OF TEKTITES AND OTHER NATURAL GLASSES. R. L. Fleischer, P. B. Price, and R. M. Walker (General Electric Research Lab., Schenectady, N. Y.). Geochim. Cosmochim. Acta, 29: 161-6(Mar. 1965).

Further fission-track dating experiments were carried out to examine the associations between tektite falls and various impact glasses. The previous ages found for Libyan desert glass by fission track dating, and for Ries Kessel glass and the Martha's Vineyard tektite by K-Ar dating, were confirmed. Although some low ages were found for samples from the Ivory Coast and the Ashanti Crater, the results supported the value of 1.3 million years found by Gentner, Lippolt, Möller, and Zähringer. Likely maximum ages are given for several impact glasses, which are apparently not associated with tektite falls. (auth)

18181 SOLUTION OF GEOLOGICAL-ENGINEERING AND HYDROGEOLOGICAL PROBLEMS BY MEANS OF ISOTOPIC METHODS. Leopold Jurkiewicz. Kwart. Geol., 8: 854-64(1964). (In Polish)

The application of radioisotopes in engineering geology and hydrogeology is discussed. Closed nuclear radiation sources were used in measuring the bulk density and humidity of soils. Typical calibration curves for some probes are given as well as principles of selecting the radioisotope tracers used in hydrogeological studies. The utility of stable complex compounds labeled by various radioactive isotope is stressed. In hydrogeological investigations based on radioisotope tracers, methods for mea-

suring ground water flows are most developed. Estimates of water resources in underground basins and determination of the relationship between these basins are discussed. The possibilities of absolute age determination of ground waters by means of natural tritium and ^{14}C, for solution of special hydrogeological problems, are also considered. (auth)

18182 DETERMINATION OF PHYSICAL PARAMETERS OF SOILS BY ISOTOPIC METHODS IN ENGINEERING GEOLOGY. Marian Borowczyk. Kwart. Geol., 8: 865-72(1964). (In Polish)

The isotopic methods, which made possible a determination and investigation of changes in physical properties of soils, are described. Investigation of this type may be carried on without disturbing the natural processes and without changing the structure and physical state of soil. Results of quantitative interpretation of consolidation process observed in an earth embankment heaped up on a peat bed 1.5 to 2.0 m thick are presented. The measurements were made using isotopic probe of the GO-62 type (20 mm in outside diameter), which may be used in determining the density of soil. (auth)

18183 THE POSSIBILITY OF TRITIUM DETECTION IN APPLICATION TO HYDROGEOLOGY. Tadeusz Florkowski. Kwart. Geol., 8: 887-96(1964). (In Polish)

The technique of the tritium application in hydrogeology is described. The physical characteristics of tritium, its origin, and its distribution in nature are discussed. Because of low tritium activity and its very low beta energy samples of tritiated water must be enriched by distillation or electrolysis. Tritium activity can be measured using the gas-counter or liquid-scintillation techniques. The sensitivity for both methods is given and health hazards for tritium as a tracer in hydrogeology are discussed. (auth)

18184 PULSED-NEUTRON EXPERIMENTS IN A BOREHOLE MODEL. William R. Mills, Jr. (Socony Mobile Oil Co., Inc., Dallas), L. Scott Allen, Richard L. Caldwell, George N. Salaita, and Tom J. Gray. Nucl. Sci. Eng., 21: 346-56(Mar. 1965).

Pulsed-neutron experiments were performed in a borehole model to determine the effects of tool position, borehole fluid, and source-detector spacing on pulsed-neutron/thermal-neutron logging. Neutron-time distributions were measured with various combinations of the above parameters in a sand model of 32.5% porosity filled with fresh water or salt water with 230 g/liter NaCl. Neutron lifetimes determined from the distributions indicate the degree of validity of the assertion that undesirable borehole effects are largely eliminated by this logging method. A numerical computer code (CUNLAP) was developed to solve the time-dependent, three-group diffusion equations which apply to borehole geometry. Results of test calculations are presented and compared to the experiments in a semiquantitative way. The numerical results are also compared to those of an analytical, fundamental-mode calculation. It is shown that the latter approach is inappropriate for the type of measurement and size of system used in experiments of this nature. (auth)

18185 DETERMINATION OF THE HYDRAULIC CHARACTERISTICS OF A COHESIONLESS SOIL BY MEANS OF THE MULTICOUNTER METHOD. J. Souffriau and L Baetsle (Belgian Nuclear Research Center S.C.K.-C.E.N., Mol, Belg.). Nucl. Struct. Eng., 1: 338-41(Mar. 1965).

A technique was developed for determination of both groundwater movement and the relative displacement of isotopes through porous media. The device automatically times the drift of a small radioisotope injection over a certain distance by means of four counting tubes. The flow direction is obtained from the time ratio between the peaks in the time-activity record. The velocity can therefore be deduced from the direction and the distance from injection point to the center of the counting tubes distance, which is constant. Measurement capabilities with this device of 1 and 200 cm per day are possible, with an error within acceptable limits. Field and laboratory tests executed with this device were compared and calibrated by existing methods. Other applications are discussed. (auth)

18186 PRECAMBRIAN GEOCHRONOLOGY OF THE EASTERN PART OF THE BALTIC SHIELD FROM THE LEAD–URANIUM–THORIUM METHOD. A. P. Vinogradov and A. I. Tugarinov. Tr. Lab. Geol. Dokembriya, Akad. Nauk SSR, No. 19. 185-204(1964). (In Russian)

The dates of magmatic events in the eastern part of the Baltic Shield were estimated using the lead–uranium–thorium method. (M.C.G.)

18187 TABLES FOR THE CALCULATION OF LEAD ISOTOPE AGES. L. R. Stieff, T. W. Stern, Seiki Oshiro, and F. E. Senftle (Geological Survey, Washington, D. C.). Geological Survey Professional Paper 334-A. 1959. 44p. $0.35(GPO).

Tables are presented for calculating geologic age by using the atomic ratios of $^{206}P/^{238}U$, $^{207}Pb/^{235}U$, $^{207}Pb/^{206}Pb$, and $^{208}Pb/^{232}Th$. Tables of values of N_d/N_p and t are given for the age equation ($N_d/N_p = \exp \lambda t - 1$), where λ is the decay constant, t is age in millions of years, N_d is the number of atoms of daughter products, and N_p is the number of atoms of parent. Values for N_{207}/N_{206} and t are also given in tabular form for the age equation $N_{207}/N_{206} = \exp \lambda_{235} t - 1/k(\exp \lambda_{238} t - 1)$, where N_{207} and N_{206} are the number of atoms of radiogenic ^{207}Pb and ^{206}Pb, respectively, and where k, the present-day atomic ratio of ^{238}U to ^{235}U, is taken as 137.7. The half lives (T) of ^{238}U, ^{235}U, and ^{232}Th used in the calculations are: $T_{238} = 4.51 \times 10^9$ years, $T_{235} = 7.13 \times 10^8$ years, and $T_{232} = 1.42 \times 10^{10}$ years. The tables cover selected values of t from 1 to 6,000 million years (6×10^9 years) at intervals of t ranging from 1 to 15 million years. Only the calculated errors in t resulting from experimental uncertainties in the determinations of the decay constants and relative abundance of ^{238}U and ^{235}U were included. An example is given for a hypothetical geologic age calculation by use of these tables. (auth)

18188 AGE DETERMINATION OF SOME ROCK SAMPLES OF THE SIMPLON AND THE MONT BLANC TUNNEL USING THE K-A METHOD. P. Menge. Thesis, Erlangen-Nuremburg, Universitat, 1963. 78p. $2.00(Gmelin, AED-DISS. 63-720). (In German)

A simple apparatus for argon determination in rock samples is described. K is determined by chemical analysis and by gamma scintillation spectroscopy. Age of Simplon rocks is 27 to 56 and of Mont Blanc rocks 117 to 176 million years. These results are compared with geological data. (Gmelin Inst.)

18189 NEUTRON SOURCE AND METHOD OF MAKING SAME. Arthur H. Youmans (to Well Surveys, Inc.). Canadian Patent 701,572. Jan. 12, 1965. Filed May 10, 1954.

A neutron source developed for well logging is pulsed and depends on the bombardment of a tritium target with deuterium ions. Vacuum pumps are eliminated because a static atmosphere of low pressure deuterium is used. The 14-Mev neutrons are produced almost free from gamma rays. The detector and the neutron source are constructed as a unit for lowering into a bore hole. (F.S.A.)

Thorium and Uranium Minerals

18190 PROSPECTING FOR URANIUM BY ANALYSIS OF OLIVE-OIL MILL WASTE. [PART] II. Juan M. Martinez Moreno, E. Bermudez Camacho, C. Gomez Herrera, and Janer del Valle (Instituto de la Grasa y sus Derivados, Sevilla, Spain). Grasas Aceite. (Seville, Spain), 15: 1-5 (1964). (In Spanish)

The distribution of uranium between the alpechin and the lipoproteic membranes up to concentrations saturated in the metal was determined for olives grown on uraniferous ground. The results showed that the function relating the concentration of uranium in the membranes to that in the aplechin moves asymptotically toward a value of the order of some 124,000 ppm uranium in the membranes. (J.S.R.)

HEALTH AND SAFETY

See *also* BIOLOGY AND MEDICINE — Radiation Hazards and Protection.

Refer also to abstracts 17453, 17741, 17821, 17830, 18078, 18157, 18269, 18288, 18733, 18737, and 19340.

18191 (AERE-M-1505) AN ANALYSIS OF RESULTS FROM DISTRICT RADIATION SURVEYS AROUND A.E.R.E. (1962–1964). B. A. J. Lister and J. E. Cook (Atomic Energy Research Establishment, Harwell (England)). Feb. 1965. 10p. Dep.; $0.30(BIS); 1s. 9d. (HMSO).

Data are summarized from measurements of environmental radioactivity in the area of the United Kingdom Atomic Energy Authority, Harwell, from 1962 through 1964. (C.H.)

18192 (EUR-2107.f) DETERMINATION DES NIVEAUX DE CONTAMINATION RADIOACTIVE DE LA CHAINE ALIMENTAIRE ET DU MILIEU AMBIANT. METHODE GENERALE D'APPROCHE. (Determination of Environmental and Food-Chain Radioactive Contamination Levels—A General Approach). G. Lacourly (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucléaires). 1964. 6p. Dep.(mn).

Equations are presented for calculation of levels of radioactive contamination in the environment and in food chains. The equations are based on a steady and uniform contamination leading to a state of equilibrium in soil, the contribution of individual fallout fission products to environmental radioactivity, the radioactivity of the diet, and the corresponding levels of radioactive contamination for each food vector. Results are compared with those obtained by other methods of calculating radiation dose to populations due to contamination of food chains by fallout fission products. (C.H.)

18193 (HW-SA-3995) CLASS I SHIPPING CONTAINER FOR FISSILE MATERIAL. C. L. Brown (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec. 22, 1964. Contract AT(45-1)-1350. 45p. (CONF-650103-4). Dep.(mn); $2.00(cy), 2(mn) CFSTI.

From International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex.

A Class I shipping container for fissile material that will meet USAEC, ICC, and other government regulations has been designed and tested. The outer jacket is an ICC-6A 55-gallon drum, and the inner container is a 9 in. ID × 19 in. long 304L stainless steel cylinder. The inner container is surrounded by three-inch thick polypropylene, with 0.02 in. Cd on both sides for neutron shielding, and three-inch thick thermal insulation for fire protection. The container has passed all tests related to normal transport and accident conditions. Accident tests consisted of a 30 ft drop onto a concrete pad; followed by a 40 in. drop onto a 6-in. diameter steel cylinder; followed by exposure to the conditions of the first hour of the standard time-temperature curve (performed by Underwriters' Laboratories, Chicago, Illinois); followed by immersion in 3 ft of water for 24 hours. Permit No. 1783 has been issued for the container by the Bureau of Explosives. The shipper will supply his own fissile material container, which will slip inside of the D19-9-20 container. The shipper's container will, in many cases, provide criticality control by virtue of geometry. Dimensions will be such that k_{eff} is ≤ 0.9 or that the mass of fissile material is less than 80%. Safe container loadings under consideration are given. Since the D19-9-20 container meets Class I requirements, any number may be shipped (or stored) together by the truck or rail carrier, and no special controls for nuclear safety are required.

18194 (ISS-64/34) CONTROLLO DELLE INSTALLAZIONI DI TELECURIETERAPIA DOTATE DI SORGENTI DI Co^{60} e Cs^{137}. (Survey Procedures of Telecurie Therapy Installations Equipped with Co^{60} and Cs^{137} Source). G. Cortellessa (Istituto Superiore di Sanita', Rome (Italy). Laboratori di Fisica). Sept. 7, 1964. 22p. Dep.(mn).

Methods, instrumentation, and procedures are described for the survey and control of contamination at telecurie-therapy installations. (auth)

18195 (LA-DC-6646) RAPID ESTIMATION OF FAST NEUTRON DOSES FOLLOWING RADIATION EXPOSURE IN CRITICALITY ACCIDENTS. THE $^{32}S(n,p)^{32}P$ REACTION IN BODY HAIR. Donald F. Petersen (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1965]. Contract W-7405-eng-36. 21p. (CONF-650302-5). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna.

Procedures are described for the determination of ^{32}P induced by the $^{32}S(n,p)^{32}P$ reaction in human hair. Applications of this test of radiation exposure are suggested for use in addition to ^{24}Na determinations in blood in cases of exposure in criticality accidents in the absence of adequate dosimetry systems or where the head and thorax receive the principal exposure. It is pointed out that a review of data from accidents indicates that the exposure of the head and thorax to doses in the region of 10,000 Rads may be the area of limiting sensitivity and that larger or smaller doses to the lower abdomen or extremities do not greatly affect either the clinical course or duration of survival. The ready availability of hair makes ^{32}P activity a simple test for the determination of neutron dose. (C.H.)

18196 (SZS-3) DER STRAHLENSCHUTZ IN DER DEUTSCHEN DEMOKRATISCHEN REPUBLIK. (Radiation Protection in the German Democratic Republic). G. Sitzlack. EINIGE BEMERKUNGEN ZUR PRAKTISCHEN DURCHFUHRUNG DER PERSONELLEN STRAHLENSCHUTZUBERWACHUNG. (Some Remarks on Practical Conduct of Personnel Radiation Protection Monitoring). W. Kraus and W. Kiesewetter (Staatliche Zentrale für Strahlenschutz, Berlin (East Germany)). Aug. 1964. 28p. Dep.(mn).

The functions and duties of the Staatliche Zentrale für Strahlenschutz are summarized. The organization of the personal monitoring program is given and discussed. The methods used in personal monitoring are briefly indicated. (J.S.R.)

18197 (Y-KB-53) HEALTH PHYSICS CONSIDERATIONS ASSOCIATED WITH THORIUM PROCESSING. C. M. West (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Jan. 19, 1965. Contract W-7405-eng-26. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Approaches to the health physics problems of thorium area and personnel monitoring are presented with emphasis on the techniques used in the thorium metallurgical processing facility at Y-12. A system was developed for area monitoring and data interpretation to avoid the complications caused by the many short-lived daughter isotopes of thorium and at the same time assure adequate information at reasonable cost. It is concluded that the bioassay techniques are inadequate for estimating internal exposures. However, the in vivo method is practicable and is utilized in Y-12. The potential internal hazard from thorium is shown to be greater than that of normal uranium but many times less than that from plutonium. (auth)

18198 PHYSIOLOGICAL FOUNDATIONS OF COSMONAUTICS AND HUMAN SURVIVAL IN SPACE. Julian Walawski (Division of General and Experimental Pathology, Academy of Medicine, Warsaw). Acta Physiol. Polon., 15: No. 5, Suppl., 23-32(1964). (In Polish)

Of the many harmful environmental conditions of space travel, such as acceleration, vibration, sudden changes of

temperature, etc., a few stand out as important unknown conditions from the point of view of extended space flights. These are the effects of ionizing radiation, extended periods of weightlessness, and sudden change of day-and-night periods and daily rhythms. The study of these effects is complicated by the fact that they are not independent. The effects of weightlessness are discussed in detail, both from the point of view of change in radiation tolerance and from direct effects of change of weight in space and on heavenly bodies. The present accumulated physiological data on reactions of humans and other living organisms to space environment are discussed, as well as the results of studies of the effects of extended bed-rest and submersion in liquids. Present evidence indicates the need for artificial gravity (i.e. spinning spacecraft) for extended space missions. (TTT)

18199 NUCLEAR FALLOUT AND LIVESTOCK SURVIVAL. Frank A. Todd (Department of Agriculture, Washington, D. C.). Agr. Eng., 44: 488-90; 493(Sept. 1963).

The effects of fallout on livestock in the event of a nuclear explosion are discussed. Consideration is given to two needs: protection against the immediate external hazard long enough to allow the fallout to decay to less hazardous levels; and protection against the persistent internal hazard from consumption of contaminated feed and water. Suggested structures for livestock are illustrated. Special attention is given to the problem of ^{90}Sr contamination. (P.C.H.)

18200 RADIOACTIVE FALLOUT AND NUTRITION. Ernst Mueller. Arch. Kinderheilk., 169: 105-12(Oct. 1963). (In German)

Close to one-half of the radioactivity distributed throughout the troposphere appears as fallout within 3 or 4 weeks after an atomic explosion. However, irradiation from fallout is a small proportion of the total irradiation received by man. According to data available in 1960, the average lifetime dosage from environmental radiation sources amounted to 3.8 Rem. Moreover, radioactive fallout is important to human populations because of the incorporation of radioisotopes into foodstuffs. Of the total ^{90}Sr retained from a typical American diet, 39% is derived from milk and milk products, 29% from leafy vegetables, 9% from bakery products, 8% from grains, 8% from fruit, and 7% from other sources. The most important effect that results from incorporation of ^{137}Cs is internal irradiation of the gonads, because of its widespread, generalized body distribution. Nearly 60% of the ^{137}Cs ingested comes from dairy products, and ~25% from meat and meat products in the American diet. At the present time, the irradiation received from this radioisotope is ~1% of that from environmental irradiation. To avoid ingestion of ^{131}I, it is possible to take advantage of its relatively short half life by using evaporated milk or dry milk powder. (TCO)

18201 DOSIMETRY OF INDIVIDUALS BY THE FILM BLACKENING METHOD. M. Oberhofer (EURATOM, Ispra, Italy). Arch. Tech. Messen, Lfg., 342: 149-52(July 1964). (In Dutch). (EUR-2264.d)

A survey is given of the use of photographic emulsions for individual dosimetry. Starting from the concept of blackening and the blackening curve, the sensitivity of photoemulsions to x and γ rays and the energy dependence of the blackening are discussed. The energy dependence of the blackening can be used for energy determination. β-dosimetry with photoemulsions and β-γ-dosimetry in mixed radiation fields are discussed. An account is then given of the qualitative and quantitative measurement of thermal and fast neutrons with photoemulsions. In conclusion, information is given concerning film badge design, calibration methods, error possibilities, and the accuracy of dosimetric techniques involving the use of photoemulsions. (auth)

18202 IONIZING RADIATION AS AN INDUSTRIAL HEALTH PROBLEM. R. B. Trewin (Hydro-Electric Power Commission, Toronto). Can Med. Assoc. J., 90: 20-3(Jan. 4, 1964).

After a survey of industrial uses of radioisotopes, the radiation protection program of the Hydro-Electric Power Commission of Ontario is described. Except for Atomic Energy of Canada Limited, it is the largest user of radioactivity in Canada. In co-operation with Atomic Energy of Canada Limited and the Canadian General Electric Co. Limited, it is now generating electricity by nuclear means. The Commission is presently operating a small pilot plant with an electrical output of 20,000 kw, and is proceeding with the construction of a larger (200,000 kw) plant which will be in operation in 1965. The problems of radiation protection involved in the safe operation of such nuclear reactors are discussed. Personnel are chosen with great care, particularly in respect of their physical fitness, academic and technical qualifications, and their sense of moral responsibility. Once selected, an adequate training program was undertaken. The number of people adequately trained, either academically or by experience in reactor operation, is still relatively small. A course in radiation protection consisting of 75 lectures was prepared and given by the Medical Services Division of the Ontario Hydro-Electric Power Commission to all nuclear station personnel, from the superintendent down to the cleaning staff. Examinations were held to help guarantee that no unqualified person would perform work which involved radioactivity. For safe and uniform operation of the nuclear stations within the organization, a manual of Radiation Protection Regulations was prepared by the Medical Services Division. These regulations are used as guides in the writing of standard operating procedures, and regulate the handling of all radiation matters in the plant. They deal specifically with such subjects as organization and administration, max permissible doses, radiological measurement and assessment, work techniques and protective equipment, radiation incidents and emergencies, shipment of radioactive materials, radioactive waste disposal, and the keeping of records related to radioactivity. The day-to-day control of the radiation protection program within nuclear stations is supervised by radiation protection officers who are health physicists. There are presently four on the staff of the Medical Services Division. The industrial physician in charge of this division is thus involved in many decisions involving radioactivity. These include selection of personnel, keeping of medical and exposure records, evaluating need and interpreting results of bioassay, application for Atomic Energy Control Board Licenses, and many other matters dealing with radioactivity in the field of industrial medicine. (BBB)

18203 FOOD IN CZECHOSLOVAKIA AS THE SOURCE OF Sr^{90}. A. Wolf (Charles Univ., Prague). Cesk. Hyg., 9: 140-4(1964).

The radioactivity of milk in Czechloslovakia was studied (content of so-called remnant activity, oxalate precipitates, and ^{90}Sr contents). From this the cumulative activity of soil was estimated and the supply of radiostrontium by food was counted from the latter result. The values of ^{90}Sr remnant activity and the food supply of ^{90}Sr on the whole correspond with data published elsewhere. (Excerpta Med., Sect. XXIII, 2: No. 1, (Jan. 1965))

18204 Sr^{90} CONTENT OF DRIED MILK IN THE PERIOD 1957–1963. V. Drasil and Z. Papezova (Inst. of Biophysics, Brno). Cesk. Hyg., 9: 145-8(1964).

The results of ^{90}Sr measurements in the period 1957 to 1963 are reported. The highest data were registered in 1958. After stopping of the H-test a decrease occurred relatively quickly. (Excerpta Med., Sec. XXIII, 2: No. 1, (Jan. 1965))

18205 RADIATION PROTECTION ORGANIZATIONS: THE ROLE OF THE HEALTH PHYSICIST. D. W. Moeller (Public Health Service, Winchester, Mass.), F. C. Kloke, and T. P. Glavin. Health Phys., 11: 215-32(Mar. 1965).

A review of the published literature shows that there are at least eight international, three national, and a dozen federal and interstate governmental agencies having active programs in the formulation of rules and regulations pertaining to radiation protection. In addition, over forty

professional societies and other groups within the United States have one or more committees active in this field. For the health physicist, such groups represent a resource in terms of consultation and advice, as well as a challenge from the standpoint of keeping abreast of their many activities. Through the periodic preparation of summary reports on the radiation protection issuances of such groups, the health physicist can do much to coordinate those phases of their programs related to his field. Through the Health Physics Society, health physicists, as a group, might also consider assuming a greater share of the responsibility for offering official guidance to some of the committees of the national advisory organizations. The various subcommittees of the Nuclear Standards Board are cited as one example where such action might be undertaken. (auth)

18206 A HELIUM LEAK-DETECTION METHOD FOR RESPIRATOR CONTROL. Hans Flyger (Atomenergikommissionen, Roskilde, Denmark). Health Phys., 11: 223-4 (Mar. 1965).

An accurate and fast method for estimating unpredictable and variable leakage from the face sealing surface of a dust mask is presented. It involves the use of a gas chamber. A person wearing a mask is placed in a chamber containing a certain concentration of a tracer gas. To avoid any influence by the canister on the leakage measurement, the respiration air is fed through the canister by means of a tube leading to the atmosphere outside the gas chamber. Helium was selected as the tracer gas because it has a low solubility in the lungs. Thus the helium concentration in the dead space of the respirator is independent of the respiratory cycle. A measurement of the ratio between the concentrations of helium in the dead space and the gas chamber represents an estimation of the leakage. (P.C.H.)

18207 FALLOUT DRILL TESTS. PERSONNEL AND EQUIPMENT RESOURCES. R. P. Vinall (Veterans Administration Center, Fargo, N. D.). Hospitals, 38: No. 18, 53-4(1964).

The mechanics of conducting a fallout survival drill that was designed to enhance staff proficiency in providing practical survival means for patients, hospital staff, and the community are discussed. (Excerpta Med., Sect. XXIII, 2: No. 2 (Feb. 1965))

18208 IMPACT TEST FOR SHIPPING CASKS OF IRRADIATED FUEL ELEMENTS. Ishikawajima-Harima Giho, 4: 313-20(July 1964). (In Japanese)

Shipping casks must withstand an impact force due to any credible accident during transportation without creating a radiation hazard in the environment. Free fall tests at 5 m were made using simplified test models to investigate the capability of lead casks of withstanding the impact force. Ring, disk, and hollow cylinder type test models, with or without steel linings, were used to represent the horizontal or vertical fall of hollow cylindrical shipping casks. Ninety-one models were tested; their weights ranged from 0.2 to 500 kg. The test results showed that lead casks could withstand the impact force with little damage. No appreciable scale effects were observed between model sizes, and the magnitudes of deformations of hollow cylindrical lead casks with various thickness of steel linings due to free fall impact at 5 m can be estimated from the test results. The steel linings are effective in limiting deformations. Appreciable shrinkages in lead height of cylindrical casks due to vertical impact force were observed, and this must be taken into account in designing the shipping casks. An effective method of limiting the vertical shrinkage of lead is to attach ribs to the inside of steel linings. (auth)

18209 RADIOACTIVE ISOTOPES OF STRONTIUM, CESIUM, AND OTHER FISSION PRODUCTS IN THE SOIL-PLANT SYSTEM. E. V. Yudintseva. Izv. Timiryazev. Sel'skokhoz. Akad., No. 2, 169-81(1964). (In Russian)

The results of studying the behavior of radioactive fission products, especially those most dangerous to man, ^{90}Sr and ^{137}Cs, in the soil-plant system led to the suggestion of several practical measures for decreasing the content of these isotopes in agricultural products. Such measures include deep burying of the fission products, liming of acid soils, introduction of various chemical compounds, and the use of appropriate fertilizers. The extent to which these measures or combinations are used would be determined by the nature of the soil, the isotopic composition of the fission products, and other conditions. Under some conditions, proper selection, use of contaminated grain as seed in a different region, and purification of light soils would be feasible. (IIC-M.G.)

18210 CURRENT AND FUTURE PROBLEMS IN ACCOUNTING FOR NUCLEAR MATERIALS. E. F. Kemp and C. J. Lyon (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). J. Brit. Nucl. Energy Soc., 4: 31-6 (Jan. 1965).

The high value of nuclear materials and the safety problems associated with their use require the institution of an accurate materials accounting system in all nuclear facilities. Both the general and technical problems connected with materials accounting are discussed and the specific issues, which arise in its application to isotopic enrichment plants, nuclear reactors, processing plants, and research and development facilities, are considered, with particular reference to the United Kingdom Atomic Energy Authority establishments. Some indication is given of the roles that plant and laboratory staff play in contributing to a successful materials control scheme and of the future problems facing them. (auth)

18211 CHEMICAL, BACTERIOLOGICAL, AND RADIOLOGICAL WARFARE. Joseph D. Stokes (Kentucky State Medical Assn., Greenville). J. Kentucky State Med. Assoc., 62: 24-30(Jan. 1964).

The effects of thermonuclear weapons are discussed with emphasis on residual nuclear radiation. The types of thermonuclear explosion, namely, high-altitude, air, surface, and sub-surface, are described. Acute radiation syndrome could be divided into five groups. At 50 to 200 R less than 50% vomited within 24 hr; there was weakness, fatigue, moderate leukopenia; less than 5% required medical care. At 200 to 450 R over 50% vomited; there was sickness for several days, then latent periods of one to three weeks; later severe leukopenia, purpura, infections, and epilation occurred; over 50% survived but were noneffective for several months. At 450 to 600 R all vomited, severe hemorrhage occurred after short latent period; there were infections and survival of less than 50% who would be noneffective over six months. At 600 to 2000 R immediate protracted vomiting and intractable bloody diarrhea persisting until death in ~7 to 10 days due to destruction of gastroenteric mucosa occurred. At several thousand R there was rapid injury to central nervous system with immediate disorientation, ataxia, confusion, and difficulty in breathing, watery diarrhea, cardiovascular collapse, survival for few hours or days. The major treatable changes of acute radiation syndrome are infection, leukopenia, anemia, and hemorrhage. Care of the patients is discussed with consideration of hospitalization, good nutrition, antibiotics, and blood, platelet, or even marrow transfusions. The symptoms of victims of chemical warfare, and the possible biological weapons, which could be employed, are also discussed, as well as defensive measures and treatment in the eventuality of the use of either. (BBB)

18212 A MEDICAL PROGRAM FOR NUCLEAR DEFENSE: A WORKABLE PLAN. Henry A. Brodkin. J. Med. Soc. New Jersey, 59: 4-7(Jan. 1962).

A plan covering medical aspects of civil defense is proposed which includes four main provisions: (1) creation of 12 autonomous regional target areas, (2) widespread education in first aid for nuclear weapons casualties, (3) collection and triage of casualties, and (4) air evacuation of certain classes of casualties. It is proposed that the Director of the Office of Civil and Defense Mobilization could divide the country into 12 autonomous regional target areas corresponding to the U. S. Civil Service Regions. Each target area would have a director and staff to control

all facets of civil defense in its zone, and be responsible to the National Director. This would keep cities and states from engaging in inadequate and impractical defense activities because a nuclear attack on a target area would cross state lines. For example, a nuclear attack zeroed on New York City would involve at least five states. A compulsory national education program in the treatment of radiation, blast, and thermal injuries should be initiated, it is suggested. Another essential step is to plan predesignated collection points for casualties along the main roads radiating from ground zero of a bombed city or area. Here they will be sorted into five classes by teams consisting of a doctor and lay assistants. Triage (the sorting of casualties into these five classes) will save time, effort, and increase the efficiency of the medical plan. The seriously injured who require major surgery and definitive treatment should be evacuated to intact hospitals. (BBB)

18213 RADIATION SAFETY IN INDUSTRY. Morris Kleinfeld (New York State Dept. of Labor, New York). J. Occupational Med., 6: 179-83(Apr. 1964).

The development of the New York State Labor Department's industrial radiation safety program is considered in terms of four phases: (1) Early regulatory effort (1930-1945). In 1930 the Industrial Commissioner appointed a committee of experts to develop a regulatory code for the industrial uses of radium. (2) Transitional period (from end of World War II to Federal Atomic Energy Act of 1954). No new code served as a basis for regulation during this period, but the State Labor Department continued to exercise control by utilizing the principles of industrial hygiene engineering, including isolation and shielding of radiation sources, ventilation of all processes where radioactive dusts and gases were generated, proper disposal of radioactive wastes, and limitation of exposure time to radiation. Periodic visits were made by the staff to installations using radiation sources to check on the safety procedures in use. (3) Promulgation of a formal radiation protection code (1954-1959). New York State Industrial Code Rule No. 38, entitled "Radiation Protection," was drawn up by a committee of experts and promulgated in 1955. (4) Revision of code and assumption of licensure responsibility (1959 to present). The code was revised to bring its radiation exposure limits into conformity with the lower values established in 1957 by the National Committee on Radiation Protection, and to achieve compatibility with corresponding AEC regulations so as to attain the essential prerequisite conditions for the transfer from the AEC to the State of responsibility for licensure and regulation of users of certain types of sources. It is suggested that the following points are essential to an effective and adequate industrial radiation safety program: (1) All radiation sources, other than those specifically exempted, should be licensed. (2) All installations and sources should be inspected regularly. (3) Radiation sources should be under the control of competent operating and safety personnel. (4) Employees should be properly instructed in safety precautions and safe working techniques. (5) Radiation exposures of workers should be monitored to assure that the permissible levels prescribed in the code are not exceeded. (6) Radiation hazards should be properly surveyed and evaluated. (7) Records of individual exposures, radiation surveys, receipt and disposal of sources, and other pertinent data should be properly maintained. (8) Hazardous areas should be posted and radiation sources labeled. (9) The regulating agency should be notified promptly of all radiation accidents. However well-written and well-administered a code may be, accidents due to human failure cannot be entirely prevented. In the past eight years, there have been 13 incidents of overexposure to radiation involving 72 workers in industry in New York State. Thirteen of these sustained radiation injury mainly to the hands. Only two of 22 exposed to significant concentrations of radioactive materials retained this material by the body and, in both instances, in small amounts. The total number of radiation workers was about 5000, indicating a low injury rate in terms of man-hours. (BBB)

18214 TOTAL BETA AND Sr^{90} ACTIVITY DETERMINATION IN THE ENVIRONS OF BRATISLAVA/C.S.S.R. St. Csupka (Hygienisch-Epidemiologischen Kreisinstitut, Bratislava). Kernenergie, 7: 726-30(Oct. 1964). (In German)

In 1962 measurements on the radioactivity in the vicinity of Bratislava were begun. The total β and ^{90}Sr activity in fallout and the factors affecting the height of the fallout were determined. After a maximum in May and November 1962, the total β activity in the air decreased in 1963 except for a temporary increase in the spring of 1963 and reached its minimum in December 1963. The ^{90}Sr activity did not show the same tendency in 1963. In the time interval from 1962 to 1963 29.5 nC/m^2 of ^{90}Sr was deposited on the surface of the earth. (auth)

18215 THE USE OF SPECIAL UNITS IN IONIZING RADIATION MEASUREMENTS. H. Rothe (Deutsche Amt fur Messwesen und Warenprufung, Berlin). Kernenergie, 7: 828-31(Dec. 1964). (In German)

Recommendations of the Office for Measuring and Materials Testing, Berlin G.D.R., for defining the units Roentgen, rad, and Curie are given. (R.E.U.)

18216 RADIOACTIVE POLLUTION OF SURROUNDINGS. EFFECTS OF RADIOCONTAMINATION ON THE BIOLOGICAL CYCLE. H. Boquet. Maroc Med., 43: 156-8(1964).

A review of measures undertaken in France to monitor radioactive contamination of the surroundings is presented. Radioactivity of the atmosphere is monitored by measuring the activity of atmospheric aerosols and that of precipitations. The results are considered in two systems. Within the system Babar the results of activity measurements are correlated with meteorological data with the aim of determining the movements of air masses. The system Alarm Radia-Air is intended for use in emergency cases when higher levels of activities are detected. Biological tests are realized and biological chains are studied through which radioactivity can accumulate in plants and animals. (Excerpta Med., Sect. XXIII, 2: No. 1, (Jan. 1965))

18217 THE PRINCIPAL NATURAL AND ARTIFICIAL RADIOACTIVE SUBSTANCES ENCOUNTERED IN THE SURROUNDINGS. G. Vacca. Maroc Med., 43: 159-66 (1964).

Information on radioactive contamination of surroundings from natural and artificial sources is summarized. Principal sources of natural radioactivity are radioactive substances in the soil and cosmic radiations producing radionuclides by impact on the atmosphere. The main source of artificial radioactivity is atomic industry, which produces radioactive contamination of the environment during extraction of radioactive minerals, isotope separation, construction and use of atomic piles, use of radioisotopes, and disposal of radioactive wastes. It was concluded that so far, few accidents accompanied with serious contamination of the surroundings have occurred during the 20 years of existence of atomic industry. (Excerpta Med., Sect. XXIII, 2: No. 1, (Jan. 1965))

18218 INDUCED RADIOACTIVITY IN FOOD PRODUCTS. Swietoslaw Bilecki. Med. Weterynar. (Poland), 20: 734-6(1964).

The presence of radioactive elements, such as ^{14}C, ^{40}K, ^{113}Sn, ^{24}Na, ^{35}S, ^{35}Cl, ^{32}P, ^{36}Cl in food is reviewed. The probability of formation of these radioisotopes, ratios of appearance in edible plant and animal tissues, half lives and other data are also discussed. (OTS)

18219 OBSERVATION OF RADIOACTIVE FALL-OUT IN NIGERIA UP TO 1961. B. N. C. Agu (Univ. of Ibadan, Nigeria). Nature, 205: 649-51(Feb. 13, 1965).

The program for systematic fallout sampling in Nigeria is described. The three sampling methods used by the United Kingdom Atomic Energy Authority for obtaining fallout samples from specific test explosions were adopted for Nigeria. The first method, which provides a sample of

deposited particulate fallout (often referred to as a sticky-paper sample), consists of exposing horizontally a 30 cm × 15 cm sheet of adhesive cellulose tape for a period of 24 hr. In the second method air is drawn continuously through a filter-paper of about 5 cm diameter, so that all particles in a known volume of air are trapped on the filter-paper. In the third, a daily rainfall sample is collected. The results obtained by the sampling methods are discussed. (P.C.H.)

18220 DOSIMETRY OF HIGH-ENERGY X-RAYS AND ELECTRONS (ESTIMATION OF ABSORBED DOSE IN WATER FROM "R" READINGS OF PRACTICAL DOSIMETER). Hideo Matsuzawa and Katsuhiro Kawashima (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 468-72(Aug. 1964). (In Japanese)

Numerical values of conversion factors available to estimate Rad from "r" were determined for several dosimeters when they were put in Lucite or water exposed to 6–30 Mv x rays or 10–30 Mev electrons. Six dosimeters that indicate "r" were employed. For radiation of a definite energy, each dosimeter measured R "r" in Lucite at the depth at which the maximum of the depth dose distribution occurs. Under the same conditions, the ionization density Q esu/cc was also measured by a parallel-plate ionization chamber. The conversion factor from "r" to Rad in Lucite was determined through the ratio of R to Q. Then the conversion factor in water was deduced. It may be concluded that the conversion factor from "r" to Rad depends on not only the construction of the dosimeter but also the type and the energy of radiation. (auth)

18221 TESTS OF POTASSIUM SUPEROXIDE CANISTERS IN A SMALL FALLOUT SHELTER. Verne L. Brechner, Robert O. Bauer, Robert F. Wolff, Robert W. M. Bethune, and John B. Dillon (Univ. of California, Los Angeles). Public Health Rept. (U. S.), 80: 225-32(Mar. 1965).

Observations in a fallout shelter under conditions of prolonged occupancy indicate that considerably larger canisters than the 500-gram containers used in rescue units may be preferable for fallout shelters. A canister of 1,250 grams provides a system capable of generating oxygen and absorbing carbon dioxide in large amounts and for sustained periods at flow rates of canister circulation of shelter air compatible with the physical labor of operating a blower. In experiments using the 500-gram KO_2 canister for shelter atmosphere control, concentration of carbon dioxide and of oxygen was not appreciably affected during the period of observation. In experiments with the 1,250-gram KO_2 canister, however, oxygen concentration rose from an initial 18% to 18.75% carbon dioxide concentration was reduced from 3.55 to 2.5%. Moreover, the operator of the manual blower experienced no syndrome of fatigue; in two experiments with the 500-gram canister such syndromes had occurred. (auth)

18222 CHARACTERISTICS OF ONE-KILOCURIE COBALT-60 GAMMA RAY SOURCE OF THE RADIOCHEMISTRY RESEARCH LABORATORY OF SHIZUOKA UNIVERSITY. Kunihiko Hasegawa (Shizuoka Univ., Shizuoka City, Japan). Rept. Liberal Arts Sci. Fac. Shizuoka Univ., 3: 173-9(Mar. 1963).

The dose distribution around the source and some other characteristics were investigated for the 1-kC ^{60}Co gamma source of the Radiochemistry Research Laboratory, Shizuoka University. The source consists of three vertical rods (each 1.45 mm ϕ × 244 mm) composed of ^{60}Co pellets, arranged coaxially. The dose rates were estimated chemically using a titanium sulfate dosimeter as well as ferric and ceric sulfate dosimeters. The observed values of dose rate were lower than those calculated, especially in the case of a ceric sulfate dosimeter. The values obtained by ferric and titanium sulfate dosimeters were in good agreement with those calculated. In tests using a test tube containing distilled water, it was observed that the temperature of water rose gradually with increased irradiation. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

18223 CIVIL DEFENSE SHELTERS AND THEIR EXPLOITATION. S. E. Bergelin. Tidsk. Mil. Halsovard, 86: 273-80(1961). (In Swedish)

Public shelters in Sweden are concentrated in the largest cities and have a capacity of 110,000 sitting accommodations. These shelters are to be made more suitable for long-time occupancy and, it is calculated, with a space of 1.5 m^2 per person. Public shelters for an additional 50,000 persons (1.5 m^2 per person) are now proposed to be built. These, as well as the old shelters, are intended for that part of the inhabitants who must remain behind at their work in central parts of the 14 biggest cities after final evacuation. These shelters shall withstand an overpressure of 10 atm. The standard shelters have room for a little more than 2 million sitting accommodations. Also, these shelters must be so equipped that they can be used for long-time occupancy and with a space of 1.5 m^2 per person. Every year standard shelters are built for about 125,000 persons. The building of a new and improved type of standard shelter will commence in July, 1961. They are to be proportioned with a space of 1.5 m^2 per person (after emergency evacuation has taken place) and have to stand an overpressure of 0.5 atm.: in places probable of becoming atom-bomb targets, an overpressure requirement of 1 atm. will be attained. The extensive building of shelters in Sweden has been economically possible owing to the shelters being used also for peacetime purposes. (TCO)

18224 TIDAL FLUCTUATIONS OF NATURAL RADIOACTIVITY OF THE ATMOSPHERE. B. Hess. Zentr. Biol. Aerosol Forsch., 11: 495-507(1964).

Tidal fluctuations in the amount of natural radioactivity of the atmosphere were demonstrated. The connection between radioactivity and the tide-producing power of sun and moon are described with two rules of selection. The influence of the power of the tides on the natural radioactivity of the atmosphere seems to derive from the radioactive expiration of the ground during the flood and ebb movement of the earth's crust. (Excerpta Med., Sect. XXIII, 2: No. 2(Feb. 1965))

18225 STUDIES OF NATURAL RADIOACTIVE NUCLIDES IN AIR FILTER AND RAIN SAMPLES. M. Stoeppler. Thesis, Mainz, Universitat, 1964. 82p. $2.00 (Gmelin, AED-DISS. 64-209). (In German)

Radiochemical methods for separation of ^{7}Be, ^{35}S, and ^{210}Po from air filters and rain samples are given. Calibration procedures for a scintillation counter for the ^{7}Be γ rays and counters for α and β rays for ^{210}Po and ^{35}S, respectively, are described. Specific activities of air and rain samples from Heidelberg, Germany, from April 1960 to July 1963 are correlated to nuclear test explosion frequencies. (Gmelin Inst.)

18226 HIGH-EFFICIENCY AIR FILTRATION. P. A. F. White and S. E. Smith, eds. London, Butterworths, 1964. 323p. $16.50.

The technology of high-efficiency filtration and principles on which the design and operation of such systems are based are discussed. Both the scientific principles and the engineering problems are considered. Topics covered include: nature of particulates involved, theory of fibrous filtration, filter materials, filter construction, filter specification and testing, ancillaries to high-efficiency filtration, principles of design of filtration installations, engineering of installations, and economics and future developments. (M.C.G.)

18227 UMWELTRADIOAKTIVITAT UND STRAHLENBELASTUNG. BERICHT I/61. (Environmental Radioactivity and Radiation Burden. First Quarterly Report, 61). Bad Godesberg, Ger., Bundesminister fur Atomkernenergie und Wasserwirtschaft, 1961. 145p. 3,-DM.

The content of radioactive materials in air, water, soil, and food materials and the radiation burden of the population in the German Federal Republic, measured during the first quarter of 1961, is reported in graphic and tabular form. (J.S.R.)

18228 SHIELD FOR IONIZING RADIATIONS. Jan. V. Weinberger and August G. Luisada (to Gentex Corp.). Canadian Patent 687,034. May 19, 1964. Filed June 15, 1962.

Thin flexible shields that may be used as garments are described. An amalgam of lead and mercury is applied to

material such as a fabric. Application can be by dipping, spraying, or stitching. (F.S.A.)

18229 DEVICE FOR THE AUTOMATIC, STEPPED TRANSPORTATION OF RADIOACTIVE PREPARATIONS TO BE MEASURED ALONG A CIRCULAR PATH FROM A STORAGE CONTAINER VIA A MEASURING FACILITY TO A COLLECTING VESSEL. Ladislav Vosahlik (to Tesla, Narodni Podnik). German Patent 1,181,827. Nov. 19, 1964. Priority date Dec. 18, 1958, Czechoslovakia.

Details of construction of the device for automatic transportation and measurement of radioactive materials are given. The measuring facility, the collecting vessel, and the storage container are mounted on a fixed plate in such a way that a regular triangle is extended by them. Below the plate there is a disc for the transportation of the preparation, which is rotatable about an axis located in the center of the regular triangle. Means are provided for the temporary rigid coupling of the disc and a cam plate actuating the rams mounted on the driving shaft. (Gmelin Inst.)

18230 SHUTTER FOR CONTAINERS STORING RADIOACTIVELY CONTAMINATED BODIES. Gerhard-Friedrich Dose and Bernhard Hoffmeister (to Krupp-Ardelt GmbH). German Patent 1,183,324. Dec. 10, 1964. Filed Dec. 21, 1960.

A shutter for containers storing radioactively contaminated bodies closes a circular opening and is composed of 5 equally triangulated blades, which are pivotally attached to the rim of the container so that they open out from and close into the center of the opening. The three lateral surfaces of the blades have a circular arc profile (convex or concave). (Gmelin Inst.)

18231 METHOD OF MONITORING LOW LEVEL RADIOACTIVITY BY THE STIMULATED GROWTH OF BACTERIA. Rene L. Engel and Giorgio Soli. U. S. Patent 3,156,821. Nov. 10, 1964. Filed June 15, 1961.

A method is described for monitoring low-level radioactivity, in which growth stimulation of hydrogen-utilizing or hydrocarbon-oxidizing bacteria is directly related to the level of radioactivity. A suspension of the bacteria is introduced into an assembly of test tubes containing culture medium, one half of which are unshielded glass tubes and one half of which are lead-shielded. The tubes are filled with H_2 and sealed. After exposure to any ionizing radiation for a considerable length of time, a measure of the amount of radiation may be obtained from a comparison of the growth rate in the shielded and unshielded tubes. The method is suitable for monitoring in the vicinity of atomic energy plants and atomic waste in the land and in the sea and for prospecting for radioactive ores. (A.G.W.)

INSTRUMENTATION

General

Refer also to abstract 19006.

18232 (AECL-2224) THERMOCOUPLE FAULT LOCATION BY TIME DOMAIN REFLECTOMETRY. D. B. Martin and A. J. Otter (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1965. 39p. Dep.; $1.00 (AECL).

The application of time domain reflectometry for fault finding in thermocouple circuitry was investigated. This technique consists of applying a fast rise pulse to the thermocouple and observing the reflections with a sampling oscilloscope. The pattern and position of the reflected pulse depend upon the fault impedance and the distance to the fault. A metal sheathed thermocouple acts as a lossy transmission line; consequently, the reflected wave is nearly exponential. Extension wire is also lossy and, if unshielded, its stray capacitance and inductance affect the pulse propagation velocity. The velocity must therefore be determined for each installation. The method is suitable for identifying faults. For accurate location, it is necessary to compare the fault reflection with a reference obtained from an identical sound thermocouple or from the same thermocouple at installation. If such a comparison is possible, it is estimated that fault location is typically accurate to within ±10% for circuits with up to 75 ft of unshielded extension wire and 25 ft of sheathed thermocouple $\frac{1}{16}$ in O.D. (auth)

18233 (BNL-8943) TEMPERATURE CONTROLLER. D. Potter and D. Stephani (Brookhaven National Lab., Upton, N. Y.). Mar. 23, 1965. Contract AT(30-2)-Gen-16. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A simplified block diagram and a schematic diagram are given for a temperature controller operating as a null device. The power control unit, off-scale detector, proportional signal, integral, rate signal, and output power supply are discussed. (D.L.C.)

18234 (EUR-CEA-FC-281) DEVELOPMENT OF FRICTION-TYPE VACUUM-GAUGES. H. W. Drawin (European Atomic Energy Community and Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre d'Études Nucléaires). Sept. 1964. 53p. (CONF-640914-1). Dep.(mn).

From Fundamental Problems of Low Pressure Measurements, Teddington, Sussex, England.

By applying modern electronic control and measuring techniques, new technical constructions of friction-type vacuum gages have been developed during the past two decades. The gages can measure pressures continuously between about 10^{-5} mm Hg and several atmospheres. An historical survey of the development of these friction type vacuum gages is given. The problem of finding an adequate analytical expression for the calibration curves which cover a pressure range of about $1:10^7$ is considered. (auth)

18235 (ISS-64/40) NUOVI MODELLI DI AMPLIFICATORI RAPIDI. (Some New Types of Fast Amplifiers). C. Felici (Istituto Superiore di Santia', Rome (Italy). Laboratori di Fisica). Nov. 17, 1964. 11p. Dep.(mn).

New types of fast amplifiers were modified by improving their characteristics of frequency response. Transistorized types are presented with gain 8, 24, and 400 and rise time 5, 7, and 12 nsec respectively. (auth)

18236 (LA-3182) HIGH-RESOLUTION SPECTROSCOPY. NEW APPARATUS AND TECHNIQUES FOR THE STUDY OF THE OPTICAL SPECTRUM OF URANIUM. David W. Steinhaus (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Sept. 15, 1963. Contract W-7405-eng-36. 61p. Dep.; $3.00(cy), 2(mn) CFSTI.

To obtain a better understanding of the properties of the uranium atom, a detailed study of the optical spectrum of uranium is being made. Because of the extremely complex spectrum from uranium atoms, high resolution spectroscopic apparatus and very accurate measurements are needed. The high resolution spectroscopic systems being used in this study and the rapid precision data reduction techniques using high speed digital computers are described. Partly as a result of this study, the practical routine spectrographic resolution limit has decreased by about a factor of six and routine wave number measurements can be made at a rate 100 times faster, with 10 times better accuracy, than was possible five years ago. (auth)

18237 (PWAC-454) DRIFT AND ENDURANCE TESTING OF CHROMEL/ALUMEL, W−5 Re/W−26 Re AND Mo/W−26 Re THERMOCOUPLES AT 1950F TO 2000F FOR 10,000 HOURS. Salvatore Fanciullo (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Aircraft Nuclear Engine Lab.). Feb. 23, 1965. Contract AT(30-1)-2789. 37p. Dep.; $2.00(cy), 1(mn) CFSTI.

Tests of $\frac{1}{8}$-inch OD Nb-1 Zr clad, alumina-insulated Chromel/Alumel (C/A), W−5 Re/W−26 Re, and Mo/W−26 Re thermocouples were conducted to determine 10,000-hour stability in inert gas at 1950 to 2000°F. The results indicate that all of the above thermocouples drifted less than one and one-half percent for the 10,000-hour period. The C/A and W−5 Re/W−26 Re tests remained within a one and one-half percent accuracy limit for the duration of the test. The Mo/W−26 Re thermocouples showed a larger inaccuracy limit due to a poor match of the thermoelements. No test thermocouple failures occurred. (auth)

18238 (WAPD-291) AN APPARATUS FOR THE MEASUREMENT OF THE THERMAL CONDUCTIVITY OF UNIRRADIATED AND (REMOTELY) OF IRRADIATED SOLIDS IN THE RANGE 100 TO 200°C. D. Jaffe (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1965. Contract AT(11-1)-Gen-14. 29p. Dep.; $2.00(cy), 1(mn) CFSTI.

A comparative type apparatus was developed for measuring the thermal conductivity of thin (0.050 to 0.150 inch) specimens of solid materials having relatively high thermal conductivities, both prior to and after irradiation. The principle of measurement involves relating the time to boil a given volume of a liquid to the specimen's thermal resistance, where Thermal Resistance = (Thickness/Area × Thermal Conductivity). The apparatus has been calibrated for use with $\frac{1}{2}$-inch square specimens having thermal resistance values in the range of approximately 1 to 10 sec-°C/cal. In this range of thermal resistances values, the precision of the apparatus was found to be ±0.06 to 0.1 sec-°C/cal. To date, all measurements have been carried out at an average specimen temperature of 120°C, but this range can be extended to 100 to 200°C without major modifications to the apparatus. Also, it is felt that the apparatus can readily be calibrated and used for measurements of specimens with thermal resistance values well above 10 sec-°C/cal. Complete procedures for the remote in-cell measurement of the thermal conductivity of irradiated specimens have been developed and are described in detail. (auth)

18239 FILM SCANNER AND ITS APPLICATION FOR ISODOSE PLOTTER AND ISODOSE SYNTHESIZER. Masaomi Takizawa (Shinshu Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 510-17(Aug. 1964). (In Japanese)

An improved type of x-ray film scanner was developed in Shinshu University Hospital. This scanner is provided with a logarithmic amplifier for the correction of non-linear characteristics of x-ray films. Further correction is done by setting the level-discriminating device, which sends out driving pulse signals to the scanner. An isodensity curve, which corresponds to an isodose curve, is plotted as a

dotted line or color scan. Monochromatic dot scan is adequate for simple dose distributions but color scan is much better to describe more complicated distributions. Isodose synthesis from two or more isodose curves is easily done by means of logarithmic amplification. The x-ray film scanner is very useful not only in the field of dosimetry but also for quantitative analysis in x-ray diagnosis. Diagnostic applications will appear in other papers. (auth)

18240 A WIDE BAND, D. C. COUPLED, FAST AMPLIFIER. M. Coli (CNEN, Frascati, Italy), S. Lupini, V. Silvestrini, and G. Penso. Nucl. Instr. Methods, 33: 298-302(Mar. 1965).

A very simple fast amplifier is described. The output pulse has a rise time of 2.5 ns with less than 15% overshoot and a gain of 10. The bandwidth of the amplifier extends up to 175 Mc and is flat up to 40 Mc. The gain is practically independent of temperature in the range from 10 to 60°C. The amplifier is completely d-c coupled and is therefore particularly suited for nuclear experiments with very high repetition rates. (auth)

18241 AN ANALOGUE RATIO CIRCUIT FOR FISSION FRAGMENT MASS DETERMINATION. G. R. Hogg and K. H. Lokan (Univ. of Melbourne). Nucl. Instr. Methods, 33: 319-21(Mar. 1965).

An analog circuit for the direct determination of fragment masses from the energies of two coincident fission fragments is described. Over the required range, the circuit operates with a resolution better than 3 amu. (auth)

18242 A 500 Mc TWISTED RING COUNTER WHOSE RESOLUTION IS LIMITED BY GATE SWITCHING SPEED ONLY. W. Hilberg (Telefunken Research Inst., Ulm, Ger.). Nucl. Instr. Methods, 33: 322-4(Mar. 1965).

A new high-speed counting scheme and circuit obtaining the maximum possible counting frequency with conventional circuit elements are described. (auth)

18243 A NEW SCALE OF TWO CIRCUIT. A. J. Oxley (Oxford Univ.). Nucl. Instr. Methods, 33: 325-8(Mar. 1965).

A circuit for a serial binary scaler using cold-cathode trigger tubes is described. The two stable states of a single tube (conducting and non-conducting) are utilized as the two states of a scale-of-two, enabling each stage to be made up from a single tube plus a minimum of other passive components. Tests of one version of the circuit did not indicate that simplicity had been achieved at the cost of reliability. The large output signals and visual display may be advantageous, but the maximum speed is restricted by the tube de-ionization time. (auth)

18244 LOGARITHMIC PULSE AMPLIFIER. James S. Lunsford (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr., 36: 461-4(Apr. 1965). (LA-DC-6772)

A solid state logarithmic pulse amplifier was developed primarily for use in single shot large dynamic range experiments. It has a risetime of less than 100 nsec, a logarithmic range of 3 decades, and a usable range of greater than 4 decades. A temperature control circuit is used to maintain critical transistors at a constant temperature to achieve a thermal stability of approximately 2% referred to input for a 10°C ambient temperature change. (auth)

18245 ION CYCLOTRON RESONANCE SPECTROMETER. Darold Wobschall (Cornell Univ., Buffalo). Rev. Sci. Instr., 36: 466-75(Apr. 1965).

A sensitive ion cyclotron resonance spectrometer designed to study low energy ion-molecule interactions in a weakly ionized gas is described. It is capable of determining simultaneously the collision frequency and average concentration of ions having a particular charge-to-mass ratio. General design considerations discussed include sensitivity, linewidth, resolution, and line broadening at high E/P. Effects of electron buildup are also discussed. The measurement chamber is intended to operate within a 1500 G, 102 cm long solenoid. Ion sources and electrode arrangements are described. Power absorption is detected by a narrow band, derivative type system for which circuit diagrams are given. The spectrometer has a resolution of about 3% and can detect an average concentration of 1-10 ions/cm^3. (auth)

18246 SUBNANOSECOND RISETIME MULTIKILOVOLT PULSE GENERATOR. Daniel F. McDonald (Braddock, Dunn, and McDonald, Inc., El Paso, Tex.), Carl J. Benning, and S. J. Brient. Rev. Sci. Instr., 36: 504-6(Apr. 1965).

A multikilovolt nanosecond pulse generator was developed which uses a new approach to the design of an extremely fast gas-discharge switch. The design concept is based on the statistical time lag which precedes an electric breakdown. The generator also employs large coaxial geometry so that extremely high operating voltages may be used. A description of instrumentation required to measure the fast risetime, high voltage pulses is included along with some typical oscilloscope traces. (auth)

18247 SMALL FRINGE-FIELD-FREE MASS SPECTROMETER. J. D. Carette and Larkin Kerwin (Universite Laval, Quebec). Rev. Sci. Instr., 36: 537-9(Apr. 1965).

A small low resolution mass spectrometer in the shape of a cylinder of over-all dimensions 8.6 × 4.5 cm is described. The use of an enveloping yoke shields the magnetic fringing field, making the spectrometer suitable for association with devices such as electron selectors. Small Alnico V pole pieces supply a field of 1800 G, which analyzes 40 ev mass 8 ions with a resolving power of 10×. (auth)

18248 SUPPRESSION OF EXCITED SPECIES FROM SPUTTER-ION PUMP BY A ZEOLITE TRAP. A. E. Barrington (Geophysics Corp. of America, Bedford, Mass.). Rev. Sci. Instr., 36: 549(Apr. 1965).

In a mass spectrometer development the performance of a twenty-stage electron-multiplier ion collector was seriously degraded by a background signal whose source was traced to a 15 liter/sec sputter-ion pump in the magnetic analyzer system. It was demonstrated conclusively that the signal was produced only when the sputter-ion pump was operating but that it was not caused by charged particles or radiation from the pump discharge. The effect was attributed to photons radiated by metastable argon atoms which were able to migrate from the pump into the multiplier section. It was possible to prevent this migration by means of a zeolite trap (molecular flow conductance 15 liter/sec) placed in series with the sputter-ion pump. (C.E.S.)

18249 MULTIPLE ELEMENT SOFT X-RAY SOURCE. A. J. Caruso and W. M. Neupert (Goddard Space Flight Center, Greenbelt, Md.). Rev. Sci. Instr., 36: 554-6(Apr. 1965).

A multiple element soft x-ray source was developed to study the soft x-ray region of the electromagnetic spectrum. The design of the source is such as to allow one to obtain radiation from six different elements without breaking vacuum. (C.E.S.)

18250 SMALL, SUBMERSIBLE, CENTRIFUGAL PUMP FOR LIQUID NITROGEN. B. M. Rustad, A. Nielsen, and L. Passell (Danish Atomic Energy Commission, Risø, Denmark). Rev. Sci. Instr., 36: 557-8(Apr. 1965).

At reactors and accelerators it is frequently necessary to refrigerate samples, targets, or other apparatus with liquid nitrogen circulated from a remote reservoir, and where liquid nitrogen cannot be supplied by gas pressure or gravity feed a mechanical pump is needed to ensure continuous flow of the liquid. Such a system consisting of a liquid hydrogen pump, a closed circulation loop, and a heat exchanger for liquefying nitrogen gas under pressure is described. (C.E.S.)

18251 ELECTROSTATIC IONIZATION PUMPS AND GAUGES-CRITERION FOR CHARGED PARTICLES ORBITING IN A LOGARITHMIC FIELD. D. J. Turner (Edwards High Vacuum International Ltd., Crawley, Sussex, Eng.). Vacuum, 14: 477-8(Dec. 1964).

In certain ionization pumps and gages, which could be described as electrostatic magnetrons, conditions must be

found such that an electron orbits freely until it suffers a collision with a gas molecule. Conditions for free orbiting are derived. (auth)

18252 ROTATING MIRROR CAMERA, MODEL 102 (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-848). (20 DRAWINGS)

A camera was designed to photograph high speed events, which are self-luminous or are illuminated by a very intense explosive light source. A 1.5 × 1 in. mirror, driven by a turbine drive, and a blast shutter are included. For details see TID-4100. (M.C.G.)

18253 A DEVICE FOR CENTERING TRACKS, VERTICES, AND FIDUCIALS ON BUBBLE CHAMBER FILM. William J. Beam. 5p. (CONF-640406-1)

From American Physical Society, Ohio Section, Spring Meeting, Cleveland.

A track centering device is described, which can center on fiducials, vertices, and track end points as well as track segments. (D.C.W.)

Radiation Detection

Refer also to abstracts 17742, 17766, 18065, 18098, 18439, 19335, and 19415.

18254 (BNL-902) SOLAR CELL INTEGRATING DOSIMETER. A. C. Muller, F. X. Rizzo, and L. Galanter (Brookhaven National Lab., Upton, N. Y.). July 1964. Contract AT-30-2-GEN-16. 8p. Dep.; $1.00(cy), 1(mn) CFSTI.

When irradiated with ^{60}Co gamma rays, commercially available p-on-n silicon solar cells suffer a reproducible and predictable amount of radiation damage. The resulting degradation in photoresponse is found to be proportional to this gamma-ray-induced radiation damage. By using a tungsten lamp as a calibrated light source with which to measure the resulting photodegradation, total doses of ^{60}Co gamma rays in the range of 10^4 to 10^8 rads may be determined, with an accuracy of ±5%. (auth)

18255 (ELI-89) A TAPE-PROGRAMMED CONTROLLER AND DIGITAL READ-OUT SYSTEM FOR THE CHALK RIVER TRIPLE-AXIS SPECTROMETER. W. D. Howell and W. R. J. Shorey (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1965. 74p. (AECL-2208). Dep.; $2.00(AECL).

A system is described, using relay logic, which provides automatic control and read-out for experiments with the Chalk River Crystal Neutron (Triple Axis) Spectrometer. In automatic operation the system is programmed, except for manual pre-selection of the scaling modes, from punched tape prepared on a computer. Manual facilities are provided for testing, initial positioning of the four spectrometer motors, and limited trial runs. A general description, a circuit description, and installation and operating instructions are included. (auth)

18256 (EURAEC-1215) SOLID-STATE NEUTRON DETECTOR. Period Covered: July 1–September 30, 1964. (Centre d'Étude de l'Énergie Nucléaire, Mol (Belgium)). Work Performed under United States–Euratom Joint Research and Development Program. Contract 099-63-10 RDB. 16p. (R-2315). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A SiC charged-particle detector is reactor-irradiated to a dose of 3.6×10^{18} nvt at 250°C. The pulse height decreased to such an extent that the peak of the α spectrum disappeared in the noise level. No annealing has been found upon heating at 500°C. At a temperature of 700°C, the detector became short circuited by diffusion of Zn into the SiC crystal. The Zn was found to come from one of the constituent parts of the encapsulation. Other detectors, where these parts are omitted, have been prepared. The pre-irradiated electrical and counting characteristics of the detectors are given. (auth)

18257 (HPR-44) A REACTIVITY METER DESIGN USED AT HBWR. A. J. W. Andersson and T. Hveding (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Nov. 1964. 52p. Dep.(mn)

An instrument for measurements of the net reactivity input to a reactor system has been designed and used at HBWR. The design is based upon extensive use of passive networks. The instrument has been tested with and without filters and with different numbers of delayed photoneutron groups. The test results are presented as gain and phase curves for reactivity to power transfer functions, and agree with theory. Operational experience was obtained during the dynamic experiment with HBWR. (auth)

18258 (HW-84250) GAMMA SPECTROMETER FOR USE IN WHOLE-BODY COUNTING. E. M. Sheen (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 1964. Contract AT(45-1)-1350. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A portable gamma spectrometer was developed combining a single channel pulse height analyzer, count-rate meter, 5-decade scalar, and a high voltage supply. All circuitry is solid state and operates from ±8 v d-c supplied by an electronically regulated, battery supply using standard 6 v d-c lantern batteries. The complete instrument, including power supply, weighs 17 lb, and approximately 100 hr of operation can be obtained per set of batteries. Integral linearity of the amplifier and analyzer is ±1%, and the usual base-line and window-width controls are provided. Accurate data readout is obtained with a sequentially switched, meter-indicated, 5-decade scalar. In addition, a count-rate meter was included to permit rapid and simple adjustment to the photopeak of the radionuclide of interest. (auth)

18259 (HA-SA-3541) IN-PILE DOSIMETRY FOR RADIATION DAMAGE STUDIES. H. H. Yoshikawa (Hanford Atomic Products Operation, Richland, Wash.). June 2, 1964. Contract AT(45-1)-1350. 20p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

The procedures followed at Hanford for in-pile dosimetry for radiation damage experiments have been described and applied to the analysis of a body of experimental data. The results strongly support the necessity for taking into account the neutron spectrum in the experimental facility to calculate exposures. By careful analysis, data from irradiations in a graphite-moderated reactor and in the core of a light-water moderated, test reactor may be made quite compatible. The exposure unit used in this analysis is recommended for further study to determine its suitability as a general exposure unit for radiation-damage studies. (D.L.C.)

18260 (ISS-64/37) UN APPARATO PER LA CALIBRAZIONE DI SORGENTI RADIOATTIVE CON IL METODO DELLE COINCIDENZE $4\pi\beta$-γ. (An Apparatus for Calibration of Radioactive Sources by Means of a $4\pi\beta$-γ Method). A. Grisanti and P. Tori (Istituto Superiore di Sanità, Rome (Italy). Laboratori di Fisica). Nov. 12, 1964. 43p. Dep.(mn).

An apparatus is described for calibration of β-γ emitters by means of a $4\pi\beta$-γ coincidence method. The processes used for testing such an apparatus and the necessary formulas for treating the experimental data are also illustrated. (auth)

18261 (NP-14685) RAZVITIE STSINTILLYATSIONNYKH I IONIZATSIONNYKH METODOV RADIOMETRII I DOZIMETRII. (Development of Scintillation and Ionization Methods in Radiometry and Dosimetry). M. I. Arsaev, V. V. Matveev, I. P. Mysev, G. M. Rudakova, P. S. Samolov, N. E. Sulimova, and V. S. Uskhov (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). [1963]. 13p. Dep.(mn).

A short review is given of the devices and methods used in radiometry and dosimetry. Performance of portable scintillation counters is discussed and parameters of various dosimeters are tabulated. Perspectives of future use of photomultipliers for recording x and γ radiation are also discussed. Descriptions are given of two instruments being developed, one for measuring the energy of

collimated radiation with a maximum energy from 5 to 90 Mev and another a universal device for measuring collimated and noncollimated radiation with a maximum bremsstrahlung spectrum from 5 to 250 Mev. Scintillation methods for x and γ radiation pulse flux dosimetry are evaluated. (R.V.J.)

18262 (NP-14686) STSINTILLYATSIONNYE SCHETCHIKI—PROGRESSIVNOE NAPRAVLENIE YADERNOGO SPEKTROMETRICHESKOGO PRIBOROSTROENIYA. (Scintillation Counters—A Progressive Step in Design of Apparatus for Nuclear Spectrometry). M. I. Arsaev, V. V. Matveev, and G. M. Rudakova (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). [1962]. 9p. Dep. (mn).

A review is given of the performance and uses of scintillation counters for recording α, β, and γ radiation and neutrons at high energies. The performance of high resolution Cherenkov counters used in recording of relativistic electron scattering at 100 Mev and gas scintillators in α spectrometry are also reviewed. (R.V.J.)

18263 (NP-14706) IZMERENIE MOSHCHNOSTI DOZY NEITRONNOGO IZLUCHENIY SHIROKOGO ENERGETICHESKOGO SPECTRA. (Measurement of Dose Rate of Neutrons with a Wide Energy Spectrum). N. A. Golovanov, N. M. Kozodaeva, B. A. Korotin, and G. K. Popkov (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). [1962]. 11p. Dep.(mn).

Descriptions are given of combined dosimetric neutron detector DDN-1 that is free from the inherent defects of isodose and dispersion detectors. The combined detector consists of two detectors (for thermal and fast neutrons) operating with one photomultiplier tube. The detector is capable of measuring doses up to 0.3 to 0.5 R/hr. A portable wide-range neutron dosimeter DN-A-1 with the sensitivity of 3 pulse/sec was developed on the basis of the DDN-1 detector. (R.V.J.)

18264 (NP-14710) UZLY I USTROISTVA ANALIZATOROV S REGISTRATOROM POSLEDOVATEL'NOGO TIPA. (Components and Construction of Analyzers with Sequential Recording). A. N. Kozyr', K. F. Kuznetsov, and I. I. Rogushin (Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). 1963. 11p. Dep.(mn).

Descriptions are given of the functional design for a multichannel analyzer with memory components distributed on delay lines. The recording system, automatic measurements, and data retrieval are discussed. (R.V.J.)

18265 (NP-14713) SOVREMENNOE SOSTOYANIE I PUTI RAZVITIYA MNOGOKANAL'NYKH ANALIZATOROV. (The Present State and Future Development of Multichannel Analyzers). I. S. Krasheninnikov (U.S.S.R. Sovet Ministrov. Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). [1963]. 23p. Dep.(mn).

A review is given of the general characteristics and performance of multichannel analyzers and their applications in nuclear physics. (R.V.J.)

18266 (NP-14724) POPRAVKI NA GEOMETRIYU PRI IZMERENII UGLOVOGO RASPREDELENIYA NA BOL'SHIKH RASSTOYANIYAKH OT ISTOCHNIKA IZLUCHENIYA. (Geometry Corrections in Measuring the Angular Distribution at Large Distances from a Source of Radiation). I. P. Mysev (Gosudarstvennyĭ Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). 1963. 10p. Dep.(mn).

Geometrical corrections are given for measuring angular distributions at large distances from the radiation source. General solutions are developed for various hypothetical angular distributions. (R.V.J.)

18267 (NP-14729) NEKOTORYE OSOBENNOSTI USILITELEI, PRIMENYAEMYKH PRI RABOTE S n-p DETEKTORAMI YADERNOGO IZLUCHENIYA. (Some Properties of Amplifiers Used with Nuclear Radiation n-p Detectors). Yu. P. Sel'dyakov (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). 1963. 14p. Dep.(mn).

A review is given of the available data on calculations, and construction of low-noise tube amplifiers used with semiconductor detectors. A design is also given of a preamplifier for the incoming section. The characteristics and performance of this preamplifier are compared with the ORTEC-101 model preamplifier. (R.V.J.)

18268 (UCRL-11336) SCINTILLATION CAMERA IMAGE RECORDING. Hal O. Anger (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 30, 1964. Contract W-7405-eng-48. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Methods of recording and interpreting pictures from the scintillation camera are described. One technique makes use of a multilens oscilloscope camera to record several images with graded brightness simultaneously on one sheet of film. When this method is used with suitable photographic film, a form of background suppression is obtained by photographic means. The effect is similar to that produced by background-subtraction circuits with mechanical scanners. Another technique involves the use of a diffusion filter to translate dot-density information into shades of gray. When pictures with sharply focused dots are observed through this filter, the individual dots are blurred, but gross patterns formed by the dots are more easily seen. Contrast versus gradation is discussed, together with methods of obtaining each. Other suggestions are made to maximize the visibility of the information in the pictures. (auth)

18269 (UCRL-11599(Rev.)) NEUTRON SPECTRA MEASURED INSIDE HUMAN PHANTOMS. Richard L. Lehman and Olga M. Fekula (Lawrence Radiation Lab., Univ. of California, Berkeley). Dec. 9, 1964. Contract W-7405-eng-48. 17p. (CONF-650302-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna.

Local neutron spectra inside human phantoms exposed 25 to 200 m from a bare pulsed reactor were measured by use of nuclear track emulsion. Under the conditions of open terrain, flat for at least 800 m in all directions, and of a bare reactor located 2m above the ground, it was found that the exposing neutron energy spectrum above 500 kev does not change with depth in a human phantom, and to a distance of at least 200 m along the air-ground interface, the exposing neutron energy spectrum above 500 kev closely resembles the emission spectrum of the neutron source. (auth)

18270 SPECTROMETER FOR MONITORING RADIOACTIVITY IN MAN. Yu. V. Sivintsev, O. M. Arutinov, V. A. Kanareikin, and M. P. Panov. At. Energ. (USSR), 18: 141-7(Feb. 1965). (In Russian)

An improved spectrometer with a NaI(Tl) crystal used for measuring radioactivity in man is described. The background count rate per 1 kg scintillator was 7,800 imp/hr at the energy range from 150 to 2,100 kev. The spectrometer sensitivity calibrated by means of ^{40}K and ^{137}Cs aqueous solutions was 1.4×10^{-11} C/kg of γ-emitting isotopes in a human organism. The average potassium content in a middle-aged man was 1.96 ± 0.08 g K/kg of the body weight and for the same age woman it was 1.53 ± 0.04 g K/kg of the body weight. A sharp rise of ^{137}Cs specific activity (from 35 to 135 pC/g K) in a human organism between Sept. 1962 and Aug. 1963 was induced by the fallout contamination of biosphere caused by nuclear explosions (tr-auth)

18271 USE OF GLYCINE AQUEOUS SOLUTIONS IN GAMMA AND FAST NEUTRON DOSIMETRY. A. P. Ibragimov and A. V. Tuichev. At. Energ. (USSR), 18: 185-7 (Feb. 1965). (In Russian)

Decomposition of concentrated glycine aqueous solutions, measured by the yield of ammonia, was used as a method of γ and fast neutron dosimetry. The yield of ammonia during glycine solution radiolysis was studied using specimens irradiated by neutron flux (500 to 2000 kw) in a reactor channel at 32 to 36°C. The total sum of γ quanta and fast neutron absorption during a 1 hour treatment in the 2000 kw

channel (1.8×10^{13}hr/cm^{3}sec) was ~105 with the order of accuracy of ±3 to 5%. Pure γ irradiation with ^{60}Co was measured at various absorption doses (10^5 to 10^8 rad) and source strengths (17, 230, and 530 R/sec). It was found that the ammonia yield was proportional to the γ and fast neutron doses. With glycine concentrations 0.1 M, the ammonia yield is somewhat lower than 1 to 2 M of the solution. The ammonia yield from reactor irradiated glycine solutions was G_{NH_3} = 1.50 to 1.65 and 1.48 to 1.60 from γ irradiation. At 18 to 36°C the yield of ammonia was not affected by temperature. (R.V.J.)

18272 LIGHT YIELD AND AMPLITUDE RESOLUTION OF MONOCRYSTALS. G. V. Miroshnikov and A. I. Kirillov. At. Energ. (USSR), 18: 187-9(Feb. 1965). (In Russian)

Applications of lithium iodide monocrystals in fast neutron spectrometry using the reaction $^6Li + n \rightarrow {}^4He + T + 4.78$ Mev were studied previously. Further studies were made to determine the fluorescence yield and amplitude resolution of LiI(Eu) monocrystals. The amplitude resolution of a 10 mm thick crystal (of natural lithium isotope mixture) and 10 and 11 mm thick crystals (90% enriched with ^{6}Li isotope) for thermal neutrons was 6.7, 8.2, and 8.8%, respectively. The fluorescence yield of the crystals for thermal neutrons was equal to the yield of β particles with Q_β energies equal to 2.8 ± 0.3, 2.4 ± 0.1, and 3.5 ± 0.1 Mev, respectively. The amplitude resolution was determined for the crystals. (R.V.J.)

18273 MEASUREMENT AND EFFICIENCY OF A TIME-OF-FLIGHT SPECTROMETER FOR FAST NEUTRONS. G. C. Bonazzola and E. Chiavassa (Università, Turin and Istituto Nazionale Fisica Nucleare, Turin). Atti Accad. Sci. Torino. I. Classe Sci. Fis., Mat. Nat., 98: 1129-38(1963-64). (In Italian)

A time-of-flight spectrometer for fast neutrons is described. A detector apparatus that signals the beginning and end of the time-of-flight interval makes possible the measurement of the angular distribution of scattered neutrons without rotation of the detector. (tr-auth)

18274 PRECISION AND RELIABILITY IN LIQUID SCINTILLATION COUNTING. Charles Matthijssen and Joseph W. Goldzieher (Southwest Foundation for Research and Education, San Antonio, Tex.). Anal. Biochem., 10: 401-8(Mar. 1965).

The use of chi-square as an index of instrument stability in liquid scintillation spectrometry was investigated and found to be inadequate for general use because of nonconformance of the output data with Poisson statistics. The numerical value of chi-square was found to be dependent on count rate, and consequently the relative standard error proved to be superior for estimating instrument performance. A nomogram for determining counting time for a specified degree of precision is given. (auth)

18275 SPARK CHAMBERS. W. A. Wenzel (Univ. of California, Berkeley). Ann. Rev. Nucl. Sci., 14: 205-38 (1964). (UCRL-11319)

Operating properties of spark chambers are considered, including the spark-discharge mechanism, detection efficiency, time and spatial resolution, magnetic-field effects, recovery time, gas composition, and chamber construction and pulsing. The relation of the discharge to the particle trajectory is discussed for tracks at an angle to the electric field and for wide-gap, limited-discharge projection, and halogen chambers. Several types of isotropic chambers — microwave, gas-amplified scintillation, streamer, and liquid-track chambers — are described. Methods for extraction and analysis of experimental data are reviewed, and the experimental use of spark chambers is discussed. 154 references. (M.J.T.)

18276 DATA SYSTEMS FOR MULTIPARAMETER ANALYSIS. R. J. Spinrad (Brookhaven National Lab., Upton, N. Y.). Ann. Rev. Nucl. Sci., 14: 239-58(1964). (BNL-7967)

The current status of data systems used in multiparameter analysis is reviewed. The emphasis is on the components of the system from the point where the event of interest exists as a pulse height or a time interval. Multichannel and multiparameter analysis is discussed, with descriptions of pulse height digitizers, time digitizers, analyzer memories, multiparameter analyzers, and event-recording analyzers. A survey of data handling equipment, computer centered systems, and future multiparameter systems is given. 71 references. (M.J.T.)

18277 SOME FACTORS AFFECTING THE COUNTING EFFICIENCY OF ^{137}Cs, ^{90}Sr, AND ^{131}I UNDER THE FORM OF MINERAL SALTS IN SUSPENSION IN SCINTILLATING GELS. Georges Germai. Bull. Soc. Roy. Sci. Liege, 33: 563-78(1964). (In French)

The effect of some factors on the counting efficiency of ^{137}Cs, ^{90}Sr, and ^{131}I in scintillating gels was considered. The factors particularly studied were the chemical nature of the mineral salts (carriers of the activity), the grain size of these salts, the radiochemical properties of the three radionuclides, the concentration of the salt in suspension in the gel, the induced activity, and the volume of the scintillating gel. (tr-auth)

18278 PULSE-HEIGHT VARIATION IN SCINTILLATION DETECTORS. Hajime Matsushita and Koji Nishiwaki (Hitachi Ltd., Tokyo). Hitachi Hyoron, 45: 1836-40(Nov. 1963). (In Japanese)

The instruments used in the experiments are a Hitachi RDA-4 γ-ray spectrometer ($1\frac{1}{2}'' \phi \times 1\frac{1}{2}''$ NaI(Tl) single crystal, Dumont 6292 or RCA 6342-A or home-made photomultiplier A) and a Hitachi RDU-2 universal surveymeter ($1'' \phi \times 1''$ NaI(Tl) single crystal, and Dumont 6291 or RCA 6199 or home-made photomultiplier B). Studies of the relation between the pulse height variation and the voltage of the focus electrode of the photomultiplier (RCA 6342A) showed that a marked shift occurred in the pulse height-count rate curve with a change in the voltage ratio of cathode to focus electrode (Vf/Vc, 0-15%); however no shift occurred in the Vf/Vc range of 20-70%. It appeared that the optimum Vf/Vc for obtaining consistent results was 30%. The variations of the amplification factor of the photomultiplier at high gamma doses or at high intensities of light are already known. A γ-ray spectrometer and a reference source of Cs^{127} (2μC) were used and definite characteristics were found for each type under Ra 0 ~ 60 mR dosages. The best was the RCA 6342A, whose variation was 0.3-0.5%/60 mR. The study of the change in the pulse height with time for the high voltage showed that in all the photomultipliers the pulse height decreased over two hours. Thermostatical examinations of a $1'' \phi \times 1''$ NaI(Tl) single crystal and a RCA 1699 revealed no evidence of variation of pulse height below 10°C, but a 0.4%/°C decrease at 16-40°C. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

18279 DOSIMETRY OF LARGE GAMMA-RAY DOSES WITH A LIQUID SCINTILLATOR. S. V. Starodubtsev, M. N. Gurskii, and A. N. Tsoy. Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 83-4(1964). (In Russian)

The performance of a liquid scintillator consisting of p-terphenyl in benzene was investigated, and it was found that when this scintillator is exposed to gamma rays its light yield decreases in proportion to the absorbed dose. On the basis of this result the construction of a dosimeter using 40 cc of distilled benzene in glass ampoules, exposed to gamma rays from ^{60}Co with a dose rate of 150 rad/sec, and then used as a solvent for p-terphenyl (5 g/liter) is proposed. The absorbed dose is determined from the decrease in the light yield, using standard scintillation apparatus. This dosimeter has low sensitivity to changes in the activator concentration over a wide range of concentrations. No change in the light yield was observed in the temperature interval 35-65°C when the benzene was exposed to a dose of 3×20^6 rad. No post-effect was likewise observed. It is claimed that this dosimeter is most convenient when measuring doses on the order of 10^5-10^7 rad, with an accuracy of about 10%. (auth)

18280 CERTAIN RESULTS FROM THE STUDY OF CORONA COUNTERS OF NEUTRONS AND THEIR USE

IN REACTOR MEASUREMENTS. V. Hristov, D. Damyanov, and N. Buchvarov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 10: 37-45(1962). (In Russian)

Corona counters of neutrons with different electrode shapes and filled with pure argon were constructed. It is shown that a stable corona and a good working plateau may be obtained by the appropriate selection of charge resistances and argon pressure. Empirical correlations were established between the corona and the working characteristics of the counters. A long cylindrical corona counter was used as the detector of an all-wave neutron counter, with which the effectiveness of the biological shielding of the IRT-1000 Reactor in Sofia was measured. (auth)

18281 USE OF SCINTILLATION COUNTERS FOR THE UNINTERRUPTED REGISTRATION OF COSMIC RADIATION. V. Zlatarov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 10: 57-69(1962). (In Russian)

The possibilities for continuous registration of cosmic rays by the use of scintillation counters are studied. The spectrum of the impulses of the scintillation counter with an area of the scintillator of ~260 cm^2 is analyzed. It is shown that in such a case the accuracy of measurement does not exceed a few percent. A detailed examination is made of the work of a device specially constructed for the purpose in which two scintillation counters operating on coincidence are used. It is shown that with an area of the scintillators of ~0.5 m^2, accuracy may reach several hundredths percent. A method of determining the intensity of cosmic rays with an error of the order of a few tenths percent by measuring the velocity of counting on two discrimination levels is also examined. (auth)

18282 CURRENT-INDUCED GAS EVOLUTION FROM ELECTRON MULTIPLIERS. B. R. F. Kendall (Nuclide Corp., State College, Penna.). J. Vacuum Sci. Technol., 2: 1-5(Jan.-Feb. 1965).

Electron multipliers are capable of emitting significant volumes of various gases while they are in operation at low pressures. Errors in ultrahigh-vacuum measurements may result. Experiments are described which show that, in a typical case, most of the evolved gas comes from the dynode and collector surfaces as a result of electron bombardment. Additional gas evolution may occur as a result of dynode resistor heating, if internal resistors are used. It appears that gas may also be released from some kinds of insulators when voltage is applied. Methods of minimizing these effects are discussed. (auth)

18283 AUTOMATIC RECORDING DEVICE. Alexej Benedek and Jan Valenta (Inst. of Physics, Czechoslovakia Academy of Sciences, Bratislava). Jaderna Energie, 10: 382-4(1964). (In Czech.)

Recording equipment is described for recording gamma spectra in conjunction with a single-channel gamma spectrometer. The pulses from the analyzer are applied to an eight stage vacuum-tube scaler through an amplifier and inverter. The impulses from the appropriate stage of the scaler are applied to a stepping mechanism, which then positions the roller that determines the vertical position of the point on the recording paper. The operation of the recorder is controlled by a relay network containing seven relays in addition to the six solenoids that actuate the stepping movements of the various working parts of the recorder. (TTT)

18284 RADIOISOTOPIC INSTRUMENTS AT THE INTERNATIONAL EXHIBIT IN BRNO, 1964. Josef Fuksa (State Commission on Distribution and Coordination of Technical Information, Prague). Jaderna Energie, 10: 447-9(Dec. 1964). (In Czech.)

A brief description of several individual pieces of radioisotope equipment is given, including three ionization chambers for gamma measurement, two ionization chambers for beta measurements, one compensating ionization chamber, collimating covers for gamma and beta sources, and an amplifier for an ionization chamber. More complete descriptions are given of: type RH radioisotope apparatus for automatic indication and regulation of the position of liquids or loose solids; type MPV for measuring the density of different materials in the range 150 to 1250 g/cm^2; type MPVO for measuring thickness; type MH for measuring liquid level; type MTG for measuring thickness; and an apparatus for measuring the ash content of coal. A list is given of organic compounds containing ^{14}C, ^{3}H, and ^{35}S exhibited. Descriptions of several radioisotope sources: ^{226}Ra needles and tubes, ^{90}Sr sources, ^{228}Ra and ^{147}Pm for luminescent pigments; and Ra–Be neutron sources. (TTT)

18285 SCINTILLATION DETECTOR—A NEW INSTALLATION FOR INVESTIGATION OF RADIOISOTOPIC DISTRIBUTION IN A LIVING ORGANISM. Milos Lokajicek. Jaderna Energie, 10: 450-2(Dec. 1964). (In Czech).

Three forms of the scintillation camera or gammagraph are described, all of which are designed to present a pattern on an oscilloscope that represents the distribution of an isotope in a living organism. The first of these is similar in principle to a pinhole camera. In this case the hole is defined by a conical lead shield, and the image is formed on a circular NaI(Tl) crystal. Seven photomultipliers behind the crystal are connected into a matrix from which are taken X and Y signals as well as a Z signal, which goes through a differential analyzer. Along with this, there is sometimes used a positron scintillation camera which depends upon the principle that the two gamma rays emitted in the annihilation of a positron are in coincidence and exactly opposite in directions. The third form of scintillation camera is called the autofluoroscope and uses 293 small NaI crystals connected by light pipes to 35 photomultipliers. Each crystal lies behind its own collimator hole and the output of the photomultipliers emits a signal giving the row and the column locating the origin of a gamma ray as well as its energy. Equations describing the performance of each of the devices are given. (TTT)

18286 A 4π GM BETA FLOW COUNTER USING A BREAK-DEAD TIME CIRCUIT. F. Leuteritz and M. Leistner (Institut fur Angewandte Radioaktivitat, Leipzig). Kernenergie, 7: 818-21(Dec. 1964). (In German)

A 4π GM beta flow counter using argon/isobutanol as the counting gas is operated with 1 and 1.5 kv high-tension having a plateau length of 200 to 400 v and a plateau slope of 2 to 4 per cent per 100 v. By using a break–dead time circuit, not only the counting rate/voltage characteristics may essentially be improved, but also the accuracy of measurements in activity determination may be increased. (auth)

18287 A LARGE-SURFACE GAS FLOW COUNTER FITTED WITH MULTIPLE COUNTER WIRES. W. Ludwig (Forschungsinstitut fur Nichteisenmetalle, Freiburg i. B.). Kernenergie, 7: 822-7(Dec. 1964). (In German)

For routine measurements of rain, drinking, and waste water activity and for measuring the activity of alpha and low-energy beta emitters in a layer of minimum thickness, a large-surface methane flow counter was developed. It may be operated with relatively low counter wire voltage ($U_H < 3$ kv, filled with gas mixtures $U_H < 2$ kv, and operated as a GM counter tube $U_H < 1$ kv) and at the 10 mv input sensitivity of the electronic counting device without using an additional preamplifier. By adequate measures, the background counting rate was reduced in such a way that, at the best, the specific background counting rate is 0.5 cpm per cm^2 of counting area in the beta-plateau region after passing through 5 cm of lead. The counting rate/voltage characteristics as a function of both counter wire thickness and counting gas mixture as well as graphs of the measuring time interval as a function of the source counting rate or the specific activity give hints to the possible applications of the counter. (auth)

18288 DOSIMETRIC MEASUREMENTS OF PLUTONIUM AEROSOLS. K. Schmidt. Kernenergie, 7: 832-6 (Dec. 1964). (In German)

In all works connected with the probable danger that plutonium is incorporated by the respiratory tract, the plutonium concentration in air must continually be con-

trolled. From the point of view of radiological protection, the concentration averaged upon total working hours of the person controlled is of most interest since, after multiplying it with breath volume of this person, it gives approximately the increase of internal body burden to be expected. Significant concentration peaks have to be indicated. The concentration technique described uses diaphragm filters. Measurements are made by means of thin CsI(Tl) crystal foils. Natural background radiation is discriminated by energy-dependent measuremements, which may be improved by partial decay of RaA. The filtration velocity is kept constant by means of a simple automatic control system. (auth)

18289 DOSIMETRY BY MEANS OF SOLID SUBSTANCES. Jozsef Patko and Istvan Berta (Kossuth Lajos Tudomanyegyetem, Alkalmazott Fizikai Intezet, Debrecen, Hungary). Magy. Radiol., 16: 303-12(Oct. 1964). (In Hungarian)

The merits of various dosimeters are discussed in detail and particular attention is given to solid-state dosimeters. It is pointed out that for the ideal dosimeter, the optical changes in the irradiated substance should be independent of: the energy of the radiation, temperature, age of the dosimeter, and the dose being measured. Fading should be a minimum, and a criterion for stability is that, for dosimeters measuring doses from a few millirads to a few rads, measurements should be 10 to 20% accurate, whereas measurements from a few rads to a few thousand rads should have an accuracy of 2 to 5%. A table shows the dose ranges for various dosimeters now in use; they are divided into two groups, those which may be used many times and those which may be used only once. Dosimeters made of crystalline substances may be used over the range of 20 to 10^4 rad; glass, 10^4 to 10^6 rad (and possibly 10^3 to 10^9 rad); synthetic materials, 10^4 to 10^9 rad; tinted synthetics, 10^3 to 10^7 rad; activated glass, 10 to 10^5 rad; and anthracene, 10^6 to 5×10^9 rad. Those for one time use are $CaSO_4$: Mn, 10^{-1} to 10^5 rad; CaF_2: Mn, 10^{-3} to 3×10^5 rad; and LiF: Mn, 10^{-1} to 10^5 rad. The characteristics of photoluminescent dosimeters are as follows: silver-activated phosphate glass ranges from 10 to 10^5 rad, the max dose rate for these is 50 rad/sec, and fading is slow; phosphate glass with high effective atomic number, 10 to 10^5 rad; phosphate glass with low effective atomic number, 10 to 10^5 rad; and silver-activated boron–lithium glass, 5×10^{-2} to 5×10^3 rad. The characteristics of thermoluminescent dosimeters are as follows: $CaSO_4$: Mn, ranges from 10^{-1} to 10^5 rad, fading is substantial; CaF_2: Mn, 1 to 10^5 rad, max dose rate 117 rad/sec, fading 10% in first hr; the same in a plastic cover, 10^{-3} to 3×10^5 rad; the same in a 1 by 12 mm tube, 10^{-2} to 3×10^5 rad, fading 16 hr, thereafter 1% daily, wavelength dependency of 7; and LiF: Al_2O_3, 10^{-1} to 10^5 rad, 4×10^3 rad/sec, fading at 50°C none in 24 hr, wavelength dependency of 1.3. The wavelength figures refer to the sensitivity factor between 1-Mev and 50-kev energy radiations. Semiconductor detectors and their relative ease of construction and light weight are also considered as dosimeter materials. It was concluded that, although the presently available dosimeters do not qualify as meeting all requirements, the photo- and thermoluminescent dosimeters are suitable for medical use and the CaS type for measuring dose rate. (BBB)

18290 CHARACTERISTICS OF THE GEIGER-MUELLER COUNTERS. Daniel Voedroes and Katalin Miklos (MTA Orvosradiologiai Kutatocsoport, Budapest). Magy. Radiol., 16: 324-9(Dec. 1964). (In Hungarian)

Preliminary to construction of a special counter for laboratory purposes, 21 Geiger-Mueller identical counters, of Hungarian manufacture, were tested for initial voltage, rise and extent of the plateau and sensitivity of the counter, dead time, sensitivity of cylindrical tubes along their axis, radial sensitivity of those with end windows, and the dependence of the sensitivity of cylindrical tubes on the direction of the radiation. A graph shows the results obtained from measurements of initial voltage and rise of plateau. It was found that initial voltage varied from 950 to 1050 v; rise of plateau varied between 4.7 and 9.6% per 100 v; and the extent of the plateau was over 250 v in each instance. Sensitivity indicated by number of impulses also varied greatly; for instance, at 1200 v the range was from 9980 to 23,200 cpm. Sixteen cylindrical tubes were tested for dead time at 1050, 1150, and 1250 v; results varied from 100 to 400 μsec. A special beta source was constructed consisting of 200 μC of ^{204}Tl, emitting 765-kev radiation. A slit was cut in the lead covering and the GM tube moved over this slit to measure the impulses along the axis. A graph shows the variations, indicating that 8 cm of the axis is sensitive, whereas the ends are not. When the maximums of the individual GM counters were compared with the figures obtained in the plateau measurements, the same sensitivity differences were found. For measuring the radial sensitivity, a 2 mm hole was drilled in the covering rather than using a slit, and it was found that the tubes with end windows showed almost no difference in readings when compared with the cylinders. However, it was found that when the anode wire was at the tube axis, it registered 10 times as many impulses as the one near the outer edge. When sensitivity depending on direction was measured in the cylindrical tubes, the resultant curve was of an asymmetrical butterfly shape. It was found in general that the measurements differed from the data supplied by the manufacturer of the GM tubes, and it is recommended that new counters be tested before use, replacements in compound counters be tested, and counters which have registered a large number of impulses be tested to determine if their characteristics remain the same. (BBB)

18291 INFLUENCE OF PRECIPITATION CONDITIONS ON THE PROPERTIES OF SILVER BROMIDE EMULSIONS. G. Danguy (Universite, Liege). Mem. Soc. Roy. Sci. Liege, 2: 1-54(1961). (In French)

Preparatory conditions for the production of homogeneous AgBr emulsions, the action of various ionizing radiations on these, and the cause of different sensitometric properties in AgBr emulsions of similar dimension and granularometric dispersion were studied. The conditions for preparation are outlined, and dispersion curves and photographs illustrate the uniformity achieved. Sensitivity toward light is given for various grain sizes; different modes of preparation produce greatly different sensitivity patterns, which fell into two main classes. The relative importance of the latent superficial image and the latent internal image with respect to ionization by light, x rays, alpha particles, and beta particles, is discussed. The x rays (40 kv) appeared to be the preferential agent for formation of an internal image in certain types of emulsions; in one type, light was only slightly less useful. Alpha particles from ^{210}Po and beta particles from ^{204}Tl created images whose relative importance depended on the mode of preparation; no general rule can be given. Information given about one material cannot be extrapolated to another. The mechanism of image formation is discussed. (BBB)

18292 BROADENING OF THE MÖSSBAUER LINE BY APPARATIVE MEANS. W. Meisel. Monatsber. Deut. Akad. Wiss. Berlin, 6: 641-3(1964). (In German)

Techniques for eliminating, or significantly reducing, the errors in some types of Mössbauer spectrometers caused by deviations from the "set" absorber rate were investigated theoretically. The possibility was considered that improvements can be effected by a suitable quadrupole circuit yielding two lines. Measurements conducted on polycrystalline ferrous sulfate heptahydrate with the 14.4-kev ^{57}Fe or ^{57}Co gamma radiation were described. The tests verified the feasibility and usefulness of the approach. (auth)

18293 INCIDENT-ANGLE DEPENDENCY IN THE ORGANIC CRYSTAL SCINTILLATORS. Kineo Tsukada (Japan Atomic Energy Research Inst., Tokyo). Nippon Butsuri Gakkaisi, 18: 706-12(Nov. 1963). (In Japanese)

In the organic scintillators such as anthracene and transstyrbene crystals, the intensity of scintillation depends on the incident angle of the particles. Studies were made of the dependencies for the particles and neutrons. Since the

surface of the scintillation crystal influences the results of experiments, the surface was treated by etching or other means. The following are described as the results of studies: (1) good symmetry around the crystal axis in the direction dependence of the scintillation; (2) difference in the direction dependence between the different molecular structures, even in the case of similar crystal structures; (3) decrease of the direction dependence with decreasing temperature; (4) difference in the time attenuation (incident angles); (5) change in the direction dependence of the scintillation with incident-particle energy; (6) difference in the direction dependence between the types of incident particles. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

18294 CALORIMETRIC STUDY OF IONIZING RADIATION. 2. THE ENERGY FLUX OF γ RAYS FROM ^{137}Cs. Yuji Takaku, Katsuhiro Kawashima, Tetsuo Inada, Kazuo Hoshino, and Hideo Matsuzawa (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 21: 801-5(Nov. 25, 1961). (In Japanese)

A calorimetric study of γ rays from a ^{137}Cs teletherapy unit was made. The measuring equipment is described in detail and illustrated. Detection sensitivity of the calorimeter was increased by using the Wheatstone bridge circuit linking four matched thermistors embedded in a pair of radiation-absorbing lead cylinders. A pair of these cylinders, whose diameter was 5 cm and height 8 cm, was suspended by nylon thread (0.5 mm dia) in a constant temperature vacuum chamber at 20°C. Each lead cylinder was split into two to allow embedding of two bead thermistors 2 cm from the distal end of the cylinder and two correction resistors (heaters) 2 cm from the anterior end of the cylinder. One of the pair of cylinders was a control and had only thermistors. Only the experimental cylinder was irradiated from the anterior end along the cylinder axis. The four thermistors were connected in the Wheatstone bridge circuit. When the cylinder absorbs the γ rays, its temperature will rise, and this will, in turn, lower resistance of the thermistors affecting electric current. Identical processes apply to the heater (2.18 kΩ) circuit. A linear relation was determined between the current in mamp through the heaters and the energy dissipated in the lead. Calibration of the recorder was made so that one reading division indicated 1.67×10^5 erg. Specific density of lead used in the calculations was 11.35 g/cm^3 and specific heat 0.0304 cal/g °C. One division indicated 0.000073°C. Correction for loss of radiation energy was introduced. It was calculated that 0.02% of the radiation will pass unabsorbed through the cylinder, 0.1% will escape from front, and back end, 0.1% from sides. Thus one division on the instrument is equivalent to 8.48×10^3 erg. The cylinder was placed 62 cm from the γ source, at which point the radiation dose was 14.8 R/min. The dosimeter used was a Victoreen Radocon 606, and the ^{137}Cs teletherapy source was 200 C. The diameter of the γ source was 3 cm; a 2-mm Cu filter was used. It was shown that the energy flux per R, E_f, and the photon flux per R, ϕ, were 3030 erg/cm^2-R and 2.86×10^9 photon/cm^2-R, respectively. The γ attenuation through copper and muscle-equivalent material, Mix P, was also measured using the same calorimeter. The results were found to agree with those obtained by the ionization chamber method. Curves showing percentage transmission vs thickness of these materials are given. (BBB)

18295 STUDY OF THE SCINTILLATION CAMERA. Hiroshi Yasukochi (Tokyo Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 246-55(May 1964). (In Japanese)

A scintillation camera device was used to study clinical applications and basic characteristics of this type of scanning equipment. The principle and the block diagram of this scintillation camera are illustrated. The image of the distribution of a radioisotope in the patient which scintillates the crystal through a pinhole is led to an oscilloscope tube by electronic circuitry. The size and brightness of dots which make up the image can be changed by a focussing dial. The distortion and sensitivity of the oscilloscopic image obtained with this camera showed better results than expected in spite of the small diameter of the scintillation crystal (5 in.). Because the diameter of the pinhole is 3 mm, the resolution decreases with increasing distance between the pinhole and the subject, but the ability to change the image on the oscilloscope, by selecting certain focus and contrast settings, compensates for the resolution loss to some degree. The sensitivity of this type of instrument is much better than a scintiscanning device, but its resolution is generally worse. In examinations of the thyroid gland, the clinical value of this method is generally better than that of scanning. In liver and kidney studies, the resolution is rather poor, but with selective dot counts and/or contrast, some defects are emphasized and the clinical value is improved. The greatest advantage of this system is that it permits the possibility of obtaining dynamic scintigrams. From this view point, this type of scanning device represents an improvement. (BBB)

18296 IMPROVEMENTS IN THERMAL NEUTRON SCINTILLATION DETECTORS FOR TIME-OF-FLIGHT STUDIES. L. A. Wraight, D. H. C. Harris, and P. A. Egelstaff (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Instr. Research, 33: 181-93 (Mar. 1965). (AERE-R-4591)

Scintillation methods of detecting thermal neutrons are reviewed and ways of preparing and using the organic borate/zinc sulfide scintillator are described which lead to a marked improvement in efficiency. In particular, a method of pulse-shape discrimination is described, based on a pronounced difference in pulse shapes from ZnS(Ag) excited by alpha particles and electrons. Methods of measuring detector efficiency or neutron flux are reviewed and a simple method is shown to be satisfactory to ½% accuracy. Using these techniques a thermal neutron efficiency of 42% is observed in the presence of 5 mR/h gamma radiation, or 52% in the absence of gamma background. Some tests were carried out on lithium glass scintillators showing that with small area detectors in applications where the gamma background is low, high efficiencies can be achieved, but where gamma backgrounds are high the zinc sulfide type is preferable. (auth)

18297 N,N,N, TRIMETHYLBORAZINE AS A LIQUID SCINTILLATOR SOLVENT FOR THERMAL NEUTRON DETECTION. H. H. Ross and H. L. Holsopple (Oak Ridge National Lab., Tenn.). Nucl. Instr. Methods, 33: 194-8 (Mar. 1965). (ORNL-P-334)

The compound, N,N,N, trimethylborazine, is shown to be an efficient solvent for the liquid scintillation process. Additionally, the natural boron-10 content of the compound enables the system to be used for the detection of thermal neutrons according to the reaction $^{10}B(n,\alpha)^7Li$. In this respect, the system is unusual in that the compound serves as both the neutron target and the scintillator solvent. When compared with conventional boron-loaded scintillators, the borazine system exhibits a number of significant advantages. The various characteristics and properties of the new scintillator recipe are described. (auth)

18298 PHOTONEUTRON SPECTROMETRY BY TIME OF FLIGHT. W. Bertozzi, P. T. Demos, S. Kowalski, F. R. Paolini, C. P. Sargent, and W. Turchinetz (Massachusetts Inst. of Tech., Cambridge). Nucl. Instr. Methods, 33: 199-212(Mar. 1965). (MIT-2098-82)

A general account is given of the methods of photoneutron spectrometry using nanosecond time of flight techniques and a pulsed electron source. Included are some details of the Massachusetts Institute of Technology electron linac facility with emphasis on the experimental geometry, the electron gun, the neutron detectors and timing and logic circuitry. Problems associated with the gamma flash, the specific bremsstrahlung associated contributions to timing accuracy and resolution, optimum pulse width and neutron detection efficiency are discussed. By means of a specific example, $^{13}C(\gamma,n)^{12}C$, the reduction of data to differential cross section is elaborated. The sources and magnitudes of backgrounds are reviewed in this example. (auth)

18299 THE CURVED-CRYSTAL SPECTROMETER AT THE UNIVERSITY OF MICHIGAN. J. J. Reidy and M. L. Wiedenbeck (Univ. of Michigan, Ann Arbor). Nucl. Instr. Methods, 33: 213-25(Mar. 1965).

A precision curved-crystal spectrometer, following the design of Seppi, Henrickson, Boehm, and DuMond, was built and put into operation. The use of a tantalum collimator and germanium crystals has greatly extended the useful range of this instrument. Results are presented concerning the relative properties of four crystals; quartz (310), quartz (112), germanium (400), and germanium ($0\bar{2}2$). Measurements of the energies of the gamma-rays following the decay of ^{198}Au and ^{199}Au are also presented. (auth)

18300 A SLOW NEUTRON CHOPPER FOR ENERGIES BETWEEN 0.1 AND 0.001 ev. B. Antonini, N. Merzagora, and G. Pauli (Centro di Studi Nucleari della Casaccia, Rome). Nucl. Inst. Methods, 33: 229-37(Mar. 1965).

A slow neutron chopper was constructed and used at the Reactor RC-1, of the Casaccia Nuclear Center, for neutron cross section measurements. The mechanical and electronic features of the instrument are described. Calibration measurements of the time-of-flight scale are reported. The neutron total cross section of gold in the energy range between 0.1 and 0.001 ev was carried out as a check of the effectiveness of the instrument. (auth)

18301 A NEW TYPE OF LINEAR RATEMETER AND OUTPUT STAGE. J. Zadicario, J. Gruenberg, and U. Sold (Soreq Research Establishment, Yavne, Israel). Nucl. Instr. Methods, 33: 238-40(Mar. 1965).

This ratemeter has a pumping circuit giving very good linearity which was not used previously in this type of instrument. The output stage for a 1 mamp recorder has a d-c amplifier with three transistors in cut-off, when there is no signal. Thus it is particularly suitable for portable instruments. Experiments indicate that linearity is better than 0.1% for the pumping circuit and better than 0.3% for the output amplifier. Temperature stability measured over the 20 – 60° range is better than 1%. (auth)

18302 A GAS PROPORTIONAL COUNTER ASSEMBLY FOR THE STUDY OF (n,α) REACTIONS. E. Kondaiah and U. T. Raheja (Tata Inst. of Fundamental Research, Colaba, India). Nucl. Instr. Methods, 33: 241-4(Mar. 1965).

A proportional counter assembly consisting of two gas counters having stable performance was constructed. Its performance is studied using americium alpha particles as well as protons and alpha particles from neutron reactions. It was possible to detect and measure the charged particles in the presence of strong neutron and gamma fields ever present in neutron reaction work. The targets are mounted internally and can be rotated from outside magnetically. The counter telescope can be used for angular distribution work. (auth)

18303 EFFECT OF FINITE GEOMETRY ON THE ENERGY DISTRIBUTION OF REGISTERED PARTICLES IN A THIN RADIATOR TELESCOPE. V. K. Voitovetskii, I. L. Korsunskii, and Yu. F. Pazhin (Kurchatov Atomic Energy Inst., Moscow). Nucl. Instr. Methods, 33: 245-51(Mar. 1965).

A function of distribution of registered particles over angles and that of distribution over energies (for the elastic scattering of neutrons by hydrogen and inelastic scattering by deuterium) are obtained for the thin radiator telescope. (auth)

18304 A TRANSISTORIZED LINEAR GATE FOR USE WITH A DOUBLE GRID IONIZATION CHAMBER. A. Sasaki (Rikkyo Univ., Tokyo) and M. Tsukuda. Nucl. Instr. Methods, 33: 252-6(Mar. 1965).

Transistorized circuit details and performance characteristics of a linear gate with increased stability and lesser power consumption is described. The circuit operates on signal levels between 0.2 ~ 5.0 v. A novel constant-delay sampling method assures an overall integral linearity of better than 0.5% between slow input pulses and narrow square output pulses of a linear gate. An application of the circuit to the measurement of alpha particle angular distributions from a thin ^{210}Po source is also given. (auth)

18305 A PULSE STRETCHER CIRCUIT FOR FAST SPECTROMETRY. G. Venturello (Universita, Turin). Nucl. Instr. Methods, 33: 268-72(Mar. 1965).

The working of an apparatus to transform pulses lasting a few nsec, produced by fast photomultipliers, into pulses lasting about a μs, of rectangular form and amplitude proportional to that of the fast pulses, is described. Pulses that can be analyzed in normal multichannels are thus obtained. (auth)

18306 A PULSE SHAPE DISCRIMINATOR WITH A TUNNEL-DIODE ZERO-CROSSER. E. Nadav and B. Kaufman (Hebrew Univ., Jerusalem). Nucl. Instr. Methods, 33: 289-92(Mar. 1965).

A simple circuit which utilizes a single tunnel-diode to determine both the start and the zero-crossing points of the differentiated current pulses of scintillation counters is described. Considerations concerning the optimization of the pulse shaping network are presented and the factors affecting the resolution summarized. The results of preliminary tests on ThC source with NaI(Tl) and CsI(Tl) crystal scintillators and on Ra–Be source with NE-213 liquid scintillator indicates a performance compatible with the known data. (auth)

18307 ON THE BEHAVIOUR OF HIGH RESISTIVITY Si SURFACE BARRIER DETECTORS. C. Bussolati (Istituto di Fisica Sperimentale, Politecnico, Milan), M. Bertolaccini, and S. Cova. Nucl. Instr. Methods, 33: 293-7(Mar. 1965).

An investigation was performed on the behavior of high resistivity (21 kΩ · cm) silicon surface barrier detectors in view of their application to electron spectroscopy. The detectors can develop depletion layers 1.3 mm thick and were used to detect ^{137}Cs and ^{113}Sn internal conversion electrons. Some anomalous effects, consisting in poor energy resolution and distortion of the spectra, were observed cooling the detectors ($T \simeq 260°K$), with low bias voltage. The effects are probably due to inhomogeneities of Si that may cause nonuniform trapping of charge carriers in the detector; they can be reduced by increasing the bias and by collimating the beam of ionizing particles so as to work with only a small portion of the surface of the detector. (auth)

18308 THE APPLICATION OF PULSE-SHAPE DISCRIMINATION TO SEPARATING PHOTOTUBE NOISE PULSE FROM SCINTILLATION PULSES. D. Landis and F. S. Goulding (Univ. of California, Berkeley). Nucl. Instr. Methods, 33: 303-5(Mar. 1965). (UCRL-11301)

A description is given of a pulse-shape discrimination technique to reduce phototube noise counts when measuring low-energy x rays. This technique uses a conventional fast-slow base-line crossing coincidence system to discriminate between the phototube noise, which consists predominately of fast rising pulses and the signal from the scintillator which may be much slower. Experimental results are given for two types of phototubes using NaI(Tl) scintillators. Under ideal conditions the noise count above the equivalent of 2 kev can be reduced to a few a minute. (auth)

18309 A FAST FISSION PRODUCT MONITOR. O. Strindehag (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Instr. Methods, 33: 314-18(Mar. 1965).

For monitoring of long-lived fission products in water a fast monitor with a Cherenkov detector was designed. The monitor responds in less than a second to ^{91}Y activities of 10^{-4} μC/cm^3 and can be used for water flows up to about 60 l/min. Detector construction and electronic equipment are described, and the selection of the photomultiplier tube is discussed. The detector efficiency is given for some important isotopes as well as the minimum activity that can be detected. The performance of the monitor in an application connected with the handling of burned out fuel elements is also reported. (auth)

18310 INFLUENCE OF THE DEAD LAYER OF SEMICONDUCTOR DETECTORS ON THE PRECISION OF ENERGY MEASUREMENTS OF α PARTICLES. G. Roux (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instr. Methods, 33: 329-31(Mar. 1965). (In French)

The influence of the dead layer of semiconductor detectors upon the shape of rays obtained by spectrometry of energy of α particles is studied theoretically. The calculated shape of the rays is given for the values of the ratio r/R_0 of the thickness of the dead layer r of the detector to the maximum range of the particles R_0 with range from 10^{-3} to 5×10^{-3} for silicon junction detectors and for different angles of collimation of the particle beam. An experimental spectrum obtained with a silicon junction detector (dead layer 0.55 μ) and a ^{210}Po α source (5.3 Mev) is in good agreement with the theoretical spectrum. (auth)

18311 PREPARATION OF SILVER AND GOLD PHOTOELECTRIC STRIP-CONVERTERS FOR USE IN BETA SPECTROSCOPY. M. AF Ugglas (Research Inst. of Physics, Stockholm). Nucl. Instr. Methods, 33: 335-7(Mar. 1965).

One of the two main features of the high luminosity and high resolution technique in beta spectroscopy is the use of extended source and converter areas divided into narrow parallel strips. The converters described were designed for investigations of angular distributions of photoelectrons and for determination of internal conversion coefficients. The converter materials were deposited on Mylar backings by vacuum evaporation and electrolysis. (C.E.S.)

18312 A RANDOM TIME GENERATOR FOR TIME-SORTER LINEARITY MEASUREMENTS. W. Falk, G. Jones, and R. Orth (Univ. of British Columbia, Vancouver, Can.). Nucl. Instr. Methods, 33: 345-6(Mar. 1965).

In order to determine the performance of a time sorter it is necessary to know the linearity of the time scale. The design and performance of a pulse generator for time sorter linearity measurements capable of producing output pulses random in time compared with the start of one of the input pulses at a rate comparable with that of this same input pulse are described. (C.E.S.)

18313 A COMPTON-REJECTION GERMANIUM SPECTROMETER. Y. Sever (Soreq Research Establishment, Yavne, Israel) and J. Lippert. Nucl. Instr. Methods, 33: 347-8(Mar. 1965).

When lithium-drifted germanium detectors are used for gamma spectrometry instead of NaI crystals, the advantage of higher resolution is much dampened by the height (relative to the photopeak) and sharpness of Compton edges. The danger of misinterpretation of a Compton edge as a photopeak in a composite spectrum is stronger in this case. A 1 $cm^2 \times 7$ mm germanium detector with a 5 mm thick lithium-drifted layer that was guarded by a 108 mm diameter NaI(Tl) well counter with wall thickness of 31 mm is described. The spectrum of ^{137}Cs with and without Compton rejection is illustrated. (C.E.S.)

18314 A THIRD ORDER AXIAL FOCUSING IN A CURRENT SHEET TYPE $\pi\sqrt{2}$ SPECTROMETER. M. Fujioka (Tokyo Inst. of Tech.). Nucl. Instr. Methods, 33: 351-2 (Mar. 1965).

The possibilities of obtaining higher order focusing by modifying the parameters of the solenoid configuration in a current sheet type $\pi\sqrt{2}$ spectrometer were investigated. Field distributions of a solenoid were examined, and it was found that a third order axial focusing can be realized in a configuration consisting of two pairs of coils with finite axial extension, but that a fourth order focusing cannot be obtained in such a simple configuration. An outline of the method of calculation and the obtained results is presented. (C.E.S.)

18315 INVESTIGATION OF FLUCTUATIONS IN MEASUREMENT OF PARTICLES IONIZATION POWER IN A SPARK CHAMBER. Yu. V. Galaktionov, F. A. Yech, and V. A. Lyubimov (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Instr. Methods, 33: 353-4(Mar. 1965).

It was previously found that at definite regimes of operating the large gap spark chamber, the luminosity of the spark breakdown depends on the ionization power of the particles passing normal to the electrodes of the chamber. The fluctuations in measurement of the ionization power of the particles in a spark chamber are investigated. Spark chambers with 15 cm gap were exposed to a beam of mesons (π) and protons at 600 Mev/c. With the aid of Cherenkov counters and absorbers mesons (π) of minimal ionization power and protons of ionization power 1.9, 2.7, and 3.4 J/J_{min} could be separated. (C.E.S.)

18316 THE CONDITIONS OF SPARK DISCHARGE EMERGENCE IN A LARGE GAP SPARK CHAMBER. V. A. Lyubimov and I. V. Sidorov (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Instr. Methods, 33: 355(Mar. 1965).

In a spark chamber the applied voltage highly exceeds the breakdown voltage but the field pulse is applied during a limited time. The minimal value of an electric field when the breakdown appears has not a unique value but is a function of the applied pulse duration at a given gap distance and gas pressure. The conditions of the breakdown emergence in a large gap spark chamber were determined. The measurements were made in spark chambers with a gap between the electrodes of 10 and 15 cm at different values of pressure and amplitudes of the field pulse. The chambers were filled with neon. (C.E.S.)

18317 MEMORY TIME FOR A SPARK CHAMBER WITH LARGE GAP BETWEEN ELECTRODES FILLED WITH PURE NEON. V. A. Lyubimov and I. V. Sidorov (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Instr. Methods, 33: 356(Mar. 1965).

It was previously shown that the memory time of spark chambers with large gaps can be regulated by adding the necessary concentration of various admixtures of electronegative gases or quenching additions to the working gas of the chamber, however, worsening the quality of the tracks. The memory time of a spark chamber filled with pure neon is regulated by changing the regime of the operation of the chamber. A chamber with a 10 cm gap is used. (C.E.S.)

18318 A METHOD OF CORRECTING FOR ACCIDENTAL COINCIDENCES. W. R. Gibson (Queen's Univ., Belfast), A. R. Johnston, R. J. Griffiths, and E. A. McClatchie. Nucl. Instr. Methods, 33: 357-8(Mar. 1965).

Multiple detector systems, which demand coincidences between particles, are discussed. A measurement of time coincident events requires a knowledge of the rate of occurrence of accidental (A) events. By using two coincidence units in parallel with the second one delayed out of coincidence it is possible to measure the true plus accidental (T + A) and accidental (A) coincidence rates simultaneously. However, it is not possible to correct exactly the (T + A) counting rate for accidental counts unless the coincidence resolutions of the two units are known. The use of a third coincidence unit to overcome the effect of differences in the coincidence resolution of the units measuring (T + A) and A without measuring their resolutions is discussed. (C.E.S.)

18319 A NEW FAST NEUTRON DETECTOR. C. West (Univ. of Liverpool). Nucl. Instr. Methods, 33: 361-2 (Mar. 1965).

Work carried out to develop a fast neutron detector, based on the effect of fast neutrons in nucleating ultrasonic cavitation in liquids, is described. If an intense sound field is set up within certain liquids, knock-on ions resulting from neutron-nucleus collisions can create nucleation centers. From these nuclei, microscopic bubbles may grow during the negative going part of the pressure cycle. Such bubbles collapse very rapidly when the pressure begins to increase, giving rise to shock waves that are propagated through the liquid and detected with a microphone. Experiments performed with tetrachloroethylene are discussed. (C.E.S.)

18320 A RELIABLE AND VERSATILE FAST DECIMAL SCALER. E. Baldinger and A. Simmen (Universitat, Basel). Nucl. Instr. Methods, 33: 363(Mar. 1965).

A 135-Mc decade including a pulse former was developed. The decade counts 2 × 5 with a classical tunnel-diode flip-flop followed by a ring counter. A description of the ring counter is given. (C.E.S.)

18321 A NEW METHOD OF TRACK RECORDING OF SPARK CHAMBER ON MAGNETIC THIN FILMS. R. Kajikawa, K. Kikuchi, H. Kobayakawa, F. Makino, A. Masaike, and Y. Ohashi (Nagoya Univ., Japan). Nucl. Instr. Methods, 33: 365-6(Mar. 1965).

A device that uses magnetic thin films as a two-dimensional detection method of positions of sparks in a spark chamber is described. The magnetic field induced by the spark current is recorded directly on a magnetic sheet, and signals due to particle tracks are read with a magnetic head. (C.E.S.)

18322 FORMATIVE TIME LAGS OF BUILD-UP PROCESS IN HALOGEN-QUENCHED COUNTERS. Satya Pal Puri (Muslim Univ., Aligarh, India). Nuovo Cimento (10), 35: 345-54(Jan. 16, 1965).

The time which elapses between the passage of the primary ionizing event and the subsequent development of the electrical pulse at the wire was investigated for the halogen-quenched counters. These delays range from a few microseconds at the threshold to a few tenths of a microsecond at an overvoltage of about 100 volts. The second part constitutes the observation of pulse forms at Geiger threshold with smaller time constants in the amplification chain in order to obtain diversely differentiated pulses. The data cannot be accounted for satisfactorily by build-up as a result of metastable action at the cathode, positive-ion bombardment of the cathode and negative-ion formation in the gas. The resonance radiation as well as the delayed emission through an intermediary stage of excited molecular argon formation do not seem to be promising. The results seem to be explainable if photoelectric effect at the cathode is considered to be a secondary mechanism. The observed delays are the transit lags of electrons due to decreased mobility at these lower values of E/p. (auth)

18323 MULTICHANNEL PULSE HEIGHT ANALYZER FOR ROCKET RESEARCH. Hirotaka Sasaki (Matsushita Electric Industries Co., Ltd., Japan). Oyo Butsuri, 33: 642-8(Sept. 1964). (In Japanese)

Studies are made to find an appropriate working system for a multichannel pulse height analyzer to be loaded on the Lambda rockets of Tokyo University for the measurement of the energy spectrum and intensity of cosmic rays at high altitude. The analyzer consists of a pulse height-to-time conversion type analog-digital converter, a ferrite core matrix memory unit, and a read-out unit. It is originally a transistorized laboratory-use analyzer, the circuit layout of which was improved to reduce its size and to obtain accurate functioning especially of the read-out system. The read-out unit is of a digital pulse transmission type that can transmit at intervals of 2.56 sec three data, namely, the channel number (0–15, 0–31), cosmic ray count (0–255), and measuring time (about 2.5 sec) on one channel of telemetrical transmission system the frequency response of which is 110 cycles per second. The system with which the read-out time is to become 1/2, 1/3, ..., 1/n for the transmission channel numbers 2, 3, ..., n respectively and the electronic data receiving scheme that covers the whole range of channel numbers and cosmic ray count are worked out. The above system was actually used for Lambda 2-2 and Lambda 3-1 rocket experiments made at Kagoshima Space Center in December 1963 and July 1964 with satisfactory results. (auth)

18324 LATEST DEVELOPMENTS IN SEMICONDUCTOR TYPE NUCLEAR RADIATION DETECTORS. Ludwik Kowalski (Technical Univ., Warsaw). Postepy Fiz., 15: 547-58(1964). (In Polish)

Developments in semiconductor type radiation detectors since the last review compiled by the authors in 1961 are reviewed. Only commercially available devices are covered. The detectors reviewed are lithium-drifted silicon diodes used especially for gamma radiation electrons, high-energy protons, and heavier particles; dE/dx-type detectors as thin as 50 microns; neutron detectors with a sensitive film of ^{10}B, ^{6}LiF, $^{235}U_3O_8S$, $^{238}U_3O_8S$, and $(CH_2)_n$; silicon semiconductor detectors with guard rings; and special arrays of detectors. Detector resolution is also covered. (TTT)

18325 A SIMPLE IONIZATION GAUGE FOR IONIZING RADIATION STUDIES ON TRANSISTORS. A. L. Barry and J. A. Bingham (Dept. of National Defence, Ottawa). Proc. IEEE (Inst. Elec. Electron. Engrs.), 53: 211(Feb. 1965).

An ionization gage for measuring the ionization produced by radiation within transistor encapsulations is described, constructed from a transistor encapsulation. (D.C.W.)

18326 THE IMAGE-RETAINING PANEL: A NEW TOOL FOR RADIOGRAPHY. Radiography, 29: 206-7(June 1963).

An image-retaining panel (IRP) is described and illustrated. In effect, the IRP is like an electrically operated photographic plate, which glows as soon as radiation strikes it, and will hold the illuminated image for at least 30 min or until the current is switched off. If an object is rested on the plate in a darkened room, and the light is switched on for a few seconds, a silhouette image of the object will be printed on the plate, the remainder of which glows with a yellowish light. Switching off the electric supply to the plate will wash off the image and leave the plate ready for the next picture. In addition to visible light, the IRP responds to x rays, near infrared, ultraviolet, and nuclear radiation, producing in each case an immediate and visible image. It is considered well within the theoretical capabilities of the IRP to show an immediate x-ray picture of part of the human body, with perhaps much less than the normal dose of x rays. Another important possibility is in electon microscopy. The IRP can produce an image with less radiation danger, because of the capacity of the plate to build up a picture from a weaker emission. To keep a permanent record of the image a sheet of photographic paper can be placed against the plate to produce a contact print. The same principle may also apply to radioactivity, where instead of merely detecting the presence of radiation, the IRP would not only detect it but show where it was falling by producing a visible light pattern. Structurally, the IRP is a metal-ceramic type panel (3 × 3 in. to 6 × 4 in.) with a fluorescent phosphor layer, operating from a d-c supply of 60 to 120 v and consuming only 5 to 30 ma. The zinc cadmium sulfide phosphor combines the property of electroluminescence under d-c excitation with a wide-band energy sensitive effect, and is sandwiched between two conducting layers held at about 100 v potential difference. Brief exposure of the panel to light or x rays triggers an electroluminescent glow with the formation of a yellowish image whose brilliance is proportional to the number of incident photons. The glow continues and the image persists for as long as the d-c voltage is maintained. The IRP behaves in certain respects like a gas-filled triode. Resolving power is about 100 lines per in., and sharpness and contrast of the retained image are maintained for up to 30 min. On disconnecting the d-c supply the phosphor relaxes, the image fades, and the panel becomes ready for re-use. As with photographic emulsions, the sensitivity to x rays is less than to light. (BBB)

18327 BORON-LOADED NEUTRON DETECTOR WITH VERY LOW γ-RAY SENSITIVITY. H. E. Jackson and G. E. Thomas (Argonne National Lab., Ill.). Rev. Sci. Instr., 36: 419-25(Apr. 1965).

A boron-loaded liquid scintillator is described which gives a much greater difference in the pulse shapes for γ rays and for slow neutrons than any of the liquids currently used. A detailed study of the pulse shapes indicates that the γ-ray sensitivity of a neutron detector filled with this liquid can be reduced by a factor of 500 with only a 5% decrease in the neutron sensitivity by application of pulse-

shape discrimination. A survey of the pulse-shape characteristics of a number of scintillators currently used, together with the results for the new liquid, is presented, and the performance of the new detector with a simple system of pulse-shape discrimination is described. (auth)

18328 DIGITAL TIME-INTERVAL ANALYZER. M. Hohenberger and H. Lindeman (Israel Inst. of Tech., Haifa). Rev. Sci. Instr., 36: 464-5(Apr. 1965).

A digital time-interval analyzer is described, which records the number of intervals between successive events of a duration less than a certain time T with great precision. The range of T lies between 10 and 1000 μsec. The application of the analyzer to the measurement of the resolving time of a scintillation counter arrangement is described. (auth)

18329 FAST SINGLE-CHANNEL PULSE-HEIGHT ANALYZER. Leonard M. Welter (Argonne National Lab., Ill.). Rev. Sci. Instr., 36: 487-92(Apr. 1965).

A circuit description and performance evaluation are presented for an analyzer capable of processing pulses with risetimes as fast as 7 nsec and widths as narrow as 10 nsec. An integral nonlinearity of ±0.15% and a differential nonlinearity of ±3.5% were obtained over its dynamic range of 100:1. The maximum input repetition rate for the lower and upper level thresholds was 13 and 5 Mc, respectively, when using a 12 nsec input pulse width. The entire analyzer is mounted on a single-sided 11.4 × 17.8 cm printed circuit board. (auth)

18330 HELIUM GAS SCINTILLATION. Robert J. Esterling and Norman H. Lipman (Univ. of California, Berkeley). Rev. Sci. Instr., 36: 493-7(Apr. 1965). (UCRL-11709)

A gas scintillation counter is described which operates to 40 atm pressure. An attempt was made to maximize the scintillation light output in helium. Helium scintillation properties studied with this counter include the effect of various wall-coating materials, gas-purity effects, the linearity of pulse height with energy, and the variation of pulse height with pressure. With purified helium and for a given amount of energy deposited in the gas, the scintillation pulse height was found to increase with pressure P approximately according to the function $kP/(1 + KP)$, where k and K are proportionality constants. A semiquantitative argument is presented, explaining this pulse-height increase with pressure in terms of electron-ion recombination times in helium. (auth)

18331 ELECTROPLATED BERYLLIUM WINDOWS. R. D. Taylor, W. A. Steyert, and A. G. Fox (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr., 36: 563(Apr. 1965). (LA-DC-6823)

Beryllium windows for low energy gamma rays for use at very low temperatures are discussed. A method to electrodeposit a rim of metal, such as Cu, Ni, or Ag, onto a Be disk so that soft soldering can be readily accomplished is described. Such units were found to be tight to He II even after repeated thermal cycling. (C.E.S.)

18332 A THREE-CRYSTAL SPECTROMETER FOR X-RAY INVESTIGATIONS INTO PRIMARY DIFFRACTION PATTERNS. Emil Bengtsson, Goesta Brogren, Gerhard Raunio, and Olof Svensson. Trans. Chalmers Univ. Technol., Gothenburg, No. 291, 1-25(1964).

A three-crystal x-ray spectrometer was constructed. Its mechanical buildup and angle determination arrangements are described, and adjustment of the apparatus is discussed. Some preliminary results from measurements of diffraction patterns, total reflection, and the curvature of lattice planes are presented. (auth)

18333 DEVELOPMENT OF SPARK CHAMBERS. A. A. Tyapkin. Vestn. Adka. Nauk SSSR, No. 12, 15-21 (Dec. 1964). (In Russian)

The development, advantages, and uses of spark chambers are reviewed. (D.C.W.)

18334 SENSITIVITY OF THICK-WALLED IONIZATION CHAMBERS TO THE BREMSSTRAHLUNG FROM AN ACCELERATOR WITH MAXIMUM W ≤ 100 Mev. A. K. Kaminskii and E. S. Lonskii. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 5, 38-45(Sept.-Oct. 1964). (In Russian)

The ionization current in thick-walled ionization chambers is calculated as a function of γ-ray energy, assuming that the γ radiation is produced by bremsstrahlung with maximum energy W ≤ 100 Mev. The calculations for aluminum and graphite walls for ionization chambers filled with air or argon are presented, the form of the γ-radiation spectrum of bremsstrahlung assumed in the calculation being that proposed by Schiff (Phys. Rev. 83: 252(1951). In order to find the relation between the ionization current and the intensity of incident radiation, it is necessary to relate the ionization produced by γ-radiation of energy W in the gaseous volume of a chamber to the ionization in the walls of the chamber. If the ionizing particles are electrons, then the initial energy spectrum of the electrons is approximately proportional to the sum of three cross sections: photo, Compton, and pair production, and is given by $n_-(W,E) = \text{const}\,[\sigma_\phi(W,E)\sigma_k(W,E) + \sigma_\pi(W,E)]$. Since the ionization loss of a positron is similar to that of an electron, the corrected form of the energy distribution is given by $n(W,E) = \text{const}\,[\sigma_\phi(W,E) + \sigma_k(W,E) + 2\sigma_\pi(W,E)]$. Separate equations can then be written for the contribution of the three processes. The dependence of the electron ionization loss on the energy of the incident radiation is shown in graphic form for the cases of air, argon, aluminum and graphite. The relation between the ionization current and the intensity of incident radiation is then given by $J(W_{max}) = epV/w\ I(W'_{max})(\int_0^{W_{max}} S(W)\bar{r}(W)\varphi(W_{max},W)\ W\ dW/\int_0^{W_{max}}\varphi(W_{max},W)\ W\ dW)$ where the sensitivity function is calculated with an accuracy of 3-5% for $0 < W < 50$ Mev for aluminum and $0 < W < 100$ Mev for graphite walls. The numerical calculations were performed on a Strela computer and plots of sensitivity vs energy are given for Al and graphite ionization chambers with air and argon. A rapid initial rise in sensitivity with energy is seen, followed by flattening with a further increase in energy. (ATD)

18335 INTENSITY MEASUREMENTS IN THE VACUUM REGION OF THE SPECTRUM. E. Ya. Shreider (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 2089-2113(Dec. 1964). (In Russian)

A review based on the literature (110 references plus 7 review papers are cited in the bibliography) of intensity measurements in the extreme (vacuum) ultraviolet is presented. It is noted that recent developments in extreme ultraviolet intensity measurement techniques have been stimulated by the needs of astrophysical research, the interest in hot plasmas, and the heightened attention to atomic and molecular photoionization phenomena. The procedures and topics mentioned and/or discussed include homochromatic photometry, heterochromatic photometry, use of radiation from thin layers as a standard, use of black-body radiation as a standard, use of synchrotrons and other secondary standards, determination of instrumental transmission spectra, measurement of absolute and relative intensities at the exit of a spectroscopic instrument, thermocouples, photoelectric detectors (employing uv stimulated phosphors and other materials), ionization chambers, photographic plates, and so on. There is also a brief discussion of nondispersion methods of measuring the integral extreme ultraviolet flux. The use of two or more procedures for checking purposes is recommended. It is suggested that the ultraviolet detectors having most advantages and fewest shortcomings are open type photomultipliers and ionization chambers filled with an inert gas. (ATD)

18336 THERMAL NEUTRON SURVEY METER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-745). (5 DRAWINGS).

A transistorized count-rate instrument used in health physics is described. It is compact, light in weight, and has permanent-type rechargeable batteries. The $B^{10}F_3$ counter is fastened to the front of the case. The instrument has three ranges with calibrations of 200, 2,000, and 20,000 neutrons · cm^{-2} · sec^{-1}. It consists of a pulse

amplifier, discriminator, duty cycle meter, transistorized 1200-v regulated power supply, and a built-in battery charger. The cabinet is 8 in. × 5½ in. × 5 in. and weighs 4 lb. The accuracy is ±6% over the operating range of battery and temperatures from 40 to 100°F. For details see TID-4100. (M.C.G.)

18337 DIAGNOSTIC PINHOLE ASSEMBLIES (Engineering Materials). (California. Univ., Livermore, Lawrence Radiation Lab.). (CAPE-952). (34 DRAWINGS).

Devices used with neutron detectors to show patterns of neutrons released in underground nuclear tests are described. The patterns of the released neutrons are picked up and reproduced at the detector. The steel tubes are 66 in. long, 25 in. OD; 40 in. long, 10 in. OD; and 20 in. long, 5 in OD. For details see TID-4100. (M.C.G.)

18338 ALPHA MONITOR (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE-1187). (12 DRAWINGS).

A fixed filter instrument was designed to monitor airborne α-emitting uranium dust. As airborne dust containing natural atmospheric radon daughters is collected, the activity increases to a quasi-equilibrium value at which time the rate of deposition equals the rate of decay. Uranium dust is observed as a rapid change from equilibrium. A differentiating circuit actuates an alarm when the rate of increase of radioactivity exceeds that expected. A vacuum pump draws the air through a filter-paper disc, which collects the dust. A scintillation detector is used to detect the α activity. The monitor alarms within 15 min when uranium dust concentration exceeds 2.1×10^{-10} μC/cm^3. This is 3.5 times the maximum permissible concentration for a 40-hr per week exposure. The instrument can measure the average weekly concentration by removal of the filter disc and the measurement of its radiation level after an appropriate decay period. For details see TID-4100. (M.C.G.)

18339 SPATIAL RECONSTRUCTION OF BUBBLE CHAMBER INTERACTIONS. Sook Hong Chin (Ohio Univ., Athens). 50p. (CONF-640406-2)

From American Physical Society, Ohio Section, Spring Meeting, Cleveland.

The computer program PARIS is described, which calculates the bubble chamber coordinates of the measured points on each track from film measurements in two different views and, using these results, calculates the curvature, angles, and ranges of the particle tracks. (D.C.W.)

18340 AN IMAGE TUBE SCINTILLATION CAMERA. Michel M. Ter-Pogossian (Washington Univ., St. Louis). 11p. (CONF-641017-4)

From Symposium on Low Energy X and Gamma Sources and Applications, Chicago.

A scintillation camera for scanning isotopes that emit low-energy gamma or x rays is described, in which the detecting element is an x-ray image amplifier. (D.C.W.)

18341 DEVICE FOR THE DISCRIMINATION BETWEEN TWO TYPES OF RADIATION. Leonard Johan de Vries (to Philips' Gloeilampenfabrieken). German Patent 1,176,765. Aug. 27, 1964. Priority date May 10, 1961, [Netherlands].

The device consists of a detector in which the two types of radiation generate two different pulses, an integrating circuit, and an oscillator circuit. The pulses from the detector are fed simultaneously into the integrator and the oscillator. The output voltages from the two circuits are added and the resulting voltage signal is demodulated and analyzed in an amplitude discriminator. The damping of the oscillator is calibrated in such a way that the envelope of the damped oscillation decreases almost like the voltage in the integrating circuit. (Gmelin Inst.)

18342 NAPHTHALENE DERIVATIVE SCINTILLATORS. R. L. Macklin (to U. S. Atomic Energy Commission). U. S. Patent 3,170,884. Feb. 23, 1965.

A liquid scintillator detector using 1-methyl naphthalene as a solvent and PPO and POPOP as the solutes was developed. Such a liquid scintillator detector, in which medium flint glass particles, with matched refractive indices, are mixed with the liquid scintillator, is described. Use of 1-methyl naphthalene solvent in the liquid scintillator can reduce the volume required by a factor of 1/1.6, and in the combined liquid and glass particle scintillator the volume required can be considerably further reduced while at the same time provide a scintillator that is at least four times more efficient in detecting gamma rays in the Mev range. (AEC)

Radiation Effects

Refer also to abstract 18743.

18343 (AD-424710) QUARTZ CRYSTAL AGING EFFECTS. Report No. 1. Quarterly Report No. 1, February 15, 1963–May 15, 1963. R. B. Belser, W. H. Hicklin, and R. A. Young (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract DA-36-039-AMC-02251(E). 37p. (A-680). $4.60(CFSTI).

Forty-five 16 Mc AT-cut quartz resonators were completed and stored in 85°C ovens for frequency measurement prior to anticipated exposure to pulsed gamma radiation. Seventeen 16 Mc AT-cut resonators, fabricated during the previous contract, of the various types of quartz (natural, natural swept, cultured, and cultured swept) were exposed to gamma radiation from a Cs-137 source at an intensity of 1.4×10^6 Rad/Hr for periods ranging from 30 seconds to 87.5 hours. The x-ray Diffraction Source Image Distortion technique was applied to the examination of 16 Mc resonators mounted in glass containers, and correlation of the patterns with the previous aging histories of the units was obtained. (OTS)

18344 (ORNL-P-1066) IN-PILE PERFORMANCE OF HIGH-TEMPERATURE THERMOCOUPLES. R. M. Carroll and P. E. Reagan (Oak Ridge National Lab., Tenn.). [1965]. Contract [W-7405-eng-26]. 9p. (CONF-650204-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Meeting on Thermocouple Technology and the Effects of Nuclear Radiation on Thermocouples, Washington, D. C.

The performance of Pt/Pt–10% Rh and W-5% Re/W-26% Re thermocouples when exposed to long-term in-pile irradiation at high temperatures was investigated. The effect of carbon, hydrogen, oxygen, and insulating materials on the life and performance of the thermocouples was also determined. (C.E.S.)

18345 RADIATION EFFECTS ON ELECTRONIC COMPONENTS AND ELECTRONIC EQUIPMENT. III. RADIATION EFFECTS ON ELECTRONIC EQUIPMENT. Shigeru Hayakawa and Kiyotaka Wasa (Matsushita Electric Industries Co., Ltd., Japan). Nat. Tech. Rept. (Matsushita Elec. Ind. Co., Osaka), 10: No. 3, 195-205(June 1964). (In Japanese)

The effects of radiation on transistor circuits and microcircuits were experimentally studied. Samples were exposed to γ rays (5×10^4 R/hr) from a ^{60}Co source of 100 curies, and to a thermal neutron flux (2×10^{12} nv) from the JRR-2 reactor. Measurements were made during γ irradiation and before and after pile irradiation. The radiation-caused change of equipment performance was analyzed in conjunction with the change of component characteristics that are responsible for the change of equipment performance. For this analysis the problems to be encountered in using or designing equipment were clarified. Though the change of equipment performance was mainly attributable to the change of characteristics of semiconductor elements, which are most sensitive to radiation, in some network composition, passive elements were responsible for the change. Selection of the bias circuit drastically affects the equipment performance. (auth)

18346 SPACE RADIATION EFFECTS ON TRANSISTOR GAIN. D. C. Sullivan (International Business Machines

Corp., Owego, N. Y.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 53: 209(Feb. 1965).

The effects of 3-Mev electrons on the gain of n-p-n silicon transistors, with and without bias during irradiation, were investigated. The gain degradation was greater for the biased transistors for collector currents less than 100 mamp. The results show that a bulk lifetime damage mechanism does not give a complete explanation of the gain behavior and indicate that ionizing radiation can induce surface channels across a reverse-biased p-n junction, resulting in significant gain degradation. (D.C.W.)

18347 EFFECTS OF NUCLEAR RADIATION IN MICROCIRCUITS. R. B. Sorkin and D. J. Hamman (Battelle Memorial Inst., Columbus, Ohio). New York, Institute of Electrical and Electronics Engineers, 1963, Paper No. 64-504, 11p, $1.00. (CONF-776-6)

From National Electronics Conference, Chicago, Oct. 1964.

It was concluded that problems arising from steady-state nuclear radiation in semiconductor microcircuits do not differ greatly from conventional solid-state circuit designs. The transistor was found to be the single most sensitive element within the microcircuit structure. However, effects of significant magnitudes occurred in other microcircuit components. The possibility exists of taking advantage of variations in other components to design for greater radiation tolerance. A study is being made to determine the circuit effects and responsible physical mechanisms of 3-Mev electron radiation on a number of semiconductor microcircuits. Data on radiation effects on transistors, diodes, resistors, and capacitors are given in tables and graphs. (M.C.G.)

18348 RADIATION SURFACE EFFECTS IN SILICON PLANAR TRANSISTORS. J. C. Peden, J. E. Freedman, and R. Luck (General Electric Co., Philadelphia). 13p. (CONF-617-16)

From Special Technical Conference on Nuclear Radiation Effects, Seattle, July 1964.

For many space missions, the surface effects, aspects of ionizing radiation damage on operating semiconductor electronic components can be much more severe than the accompanying bulk damage aspect. It was previously shown that for gas encapsulated mesa transistors electrically stressed during irradiation, large surface effects can occur at doses of 10^4 rads (air). Similarly, experiments indicated that surface effects on many silicon planar transistors and diodes can be quite severe. The data indicated significant effects on planar devices for doses of 10^4 to 10^7 rads (air). Increases in transistor collector-base leakage current, I_{CBO}, and diode reverse current, I_R, can be severe and quite varied on many units. Transistor gain degradations can occur rapidly and the effects do not recover quickly after removal of radiation and bias. Large variations in the degree of passivation, amount of surface impurities, etc., in planar devices can occur within a given manufacturing process and vary from one manufacturing process to another. The experimental data supported this conclusion in that some planar devices appeared to have very stable collector-base junctions as indicated by I_{CBO} variations, while others, made in a similar fashion, did not. Also, for all the devices tested including those with stable collector-base junctions, large gain degradations occurred. This indicated that the degree of passivation and/or control of contaminants in the base-emitter junction region, in general, is not as well controlled as that in the collector-base region. (auth)

ISOTOPE TECHNOLOGY

General

18349 FUTURE USES OF LARGE RADIATION SOURCES. Henry Seligman. Intern. At. Energy Agency Bull., 7: No. 1, 23-30(Mar. 1965).

Uses of radiation sources, how they are made, how much power can be obtained from them, and future developments are discussed. The possibilities of cheap radiation from large irradiators are considered. Uses in chemistry, vulcanizing by radiation, radiation synthesis, and medical uses are described. (M.C.G.)

Industrial Applications

Refer also to abstracts 18009 and 18284.

18350 (EUR-2225.d) ENTWICKLUNG EINER STEUERUNG FUR EINE ATOMATISCHE KOHLEABBAUMASCHINE. (Design of a Control System for an Automatic Coal-Cutter). K. Schmidt (Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany)). Jan. 1965. Dep. (mn).

A description is given of a measuring head designed for controlling automatic coal-cutters. In it, use is made of the variation in the backscattering of the Bremsstrahlung of a β-emitter from coal and rock in order to measure the thickness of the coal layer. The Bremsstrahlung source consists of 500 mC of krypton-85 with a lead target 0.1 mm thick. The intensity of the scattered radiation is measured with a GM counter. The electronics of the measuring head exhibit the intrinsic safety characteristics required in mining. Coal layers 0-8 cm thick on top of rock can be reliably measured to an accuracy of within 10%. (auth)

18351 THE APPLICATION OF NUCLEAR SCIENCE IN AGRICULTURE. Atomics, [18]: 22-5(Mar.-Apr. 1965).

The use of radiation sources in plant nutrition studies and mutation induction is reviewed. Three major factors are involved in the improvement of plant nutrition for which radiation and tracers are used: environmental photosynthesis; water control, such as making available an appropriate carrier for nutrient transfer; and salt uptake, such as making plant food available in the proper form. The world wide use of radiation in agriculture is briefly discussed. (P.C.H.)

18352 PREMIER SYMPOSIUM SUR L'APPLICATION DES SCIENCES NUCLEAIRES EN AGRONOMIE ORGANISE PAR LE C.A.M.I.R.A., LE 21 OCTOBRE 1963. (First Symposium on Application of Nuclear Science in Agronomy. Organized by the C.A.M.I.R.A., Gembloux, Belgium, October 21, 1963). Constant Corin (Institut Agronomique, Gembloux, Belg.). Bull. Inst. Agron. Sta. Rech. Gembloux, 31: 445-593(1963). (In French). (CONF-631001)

Fourteen papers presented at the first symposium on application of nuclear science in agronomy are included. Individual abstracts were prepared for five papers. (J.S.R.)

For abstracts of individual papers see: 17527, 17528, 17810, 17811, and 18353.

18353 PROLONGATION BY IRRADIATION OF THE CONSERVATION TIME OF BLANCHED VEGETABLES. J. Seeger, L. Bolly, and M. De Proost. Bull. Inst. Agron. Sta. Rech. Gembloux, 31: 584-8(1963). (In French)

The conservation time at 0 or 5°C of blanched vegetables can be considerably prolonged by irradiation at doses from 0.1 to 0.5 MRad. This time varies according to the dose applied, the type of vegetable, and the storage temperature. At 5°C it is from 3 to 30 days; at 0°C it can reach 16 to 90 days. (tr-auth)

18354 RADIATION PROCESSING. S. A. Barker. Discovery, 24: No. 3, 18-21(Mar. 1965).

A review is presented on the commercial radiation processing of products in the U. S. The mechanism of radiation, improved products, cheaper processes, making semiconductors, and future prospects are considered. (P.C.H.)

18355 IRRADIATION PRESERVATION OF PACIFIC COAST SHELLFISH. I. STORAGE LIFE OF KING CRAB MEATS AT 33° AND 42°F. D. Miyauchi, M. Eklund, J. Spinelli, and N. Stoll (Bureau of Commercial Fisheries, Seattle). Food Technol., 18: 138-42(1964).

King crab meats packed in cans, irradiated at 0.1–0.6 MegaRad and stored at 42 and 33°F, were given sensory evaluation. Doses of 0.2 and 0.4 MegaRad were judged to be the most suitable for the storage-life studies that followed. At 33°F, the storage life of five different lots of irradiated crab meat varied from 4 to more than 6 weeks, whereas the unirradiated control samples had a storage life of about 1 week. The storage life of radiopasteurized crab meat was more than twice as long at 33° as at 42°F. With irradiated crab meat, vacuum-packing inhibited the rate of degradation of quality as measured by sensory and bacteriological tests and increased the storage life by at least 1 week over that of air-packed samples. (auth)

18356 IRRADIATION PRESERVATION OF PACIFIC COAST SHELLFISH. II. RELATION OF BACTERIAL COUNTS, TRIMETHYLAMINE AND TOTAL VOLATILE BASE TO SENSORY EVALUATION OF IRRADIATED KING CRAB MEAT. J. Spinelli, M. Eklund, and D. Miyauchi (Bureau of Commercial Fisheries, Seattle). Food Technol., 18: 143-7(1964).

Total bacterial plate counts, trimethylamine (TMA), and total volatile base (TVB) production were studied in vacuum-packed king crab meat irradiated at 0, 0.2, and 0.4 MegaRad and stored at 33 and 42°F. In the irradiated crab meat, bacterial counts approached 1×10^8 per g before significant changes were noted by sensory judgments, whereas populations of slightly over 1×10^6 per g produced significant sensory changes in the unirradiated product. The bacteria that survived and grew in the early stages of storage in the irradiated product were quite feeble in their ability to produce changes in TVB and TMA, and changes in these two indexes were only gradual until bacterial counts approached 1×10^8 per g. Sensory judgments correlated well with TMA and TVB nitrogen content in the irradiated product until these values exceeded 0.9 and 12.0 mg%, respectively. Therefore, sensory judgments showed only a fair correlation with these indexes. The distribution pattern of bacterial counts, TMA, and TVB nitrogen values from four replicates of irradiated king crab meat showed that 3 weeks of shelf life may confidently be predicted when the product is irradiated at 0.2 MegaRad and stored at 33°F. The shelf life was increased to 6 weeks when the product was irradiated at 0.4 MegaRad and stored under the same conditions. At 42°F, the shelf life was only 2 weeks for the product irradiated at 0.2 MegaRad and 3 weeks for the product irradiated at 0.4 MegaRad. (auth)

18357 LIQUID LEVEL MEASUREMENT USING NUCLEAR METHODS. Denis Taylor. Ind. Electron., 1: 404-6(May 1963).

The design and application of radioisotope level measuring devices are discussed. Nuclear level gages can operate entirely from outside the containing vessel. They may be designed to provide on/off control at a fixed level in the vessel, or to provide continuous indication of level over a short range. There are two basic methods of level measurement using radiation techniques. The first involves the mounting of a γ-emitting radioactive source inside a float, or in a float arm positioned inside the

vessel. Its position is then located by means of an external detector. The second method depends on the difference between the attenuation of the γ rays in passing through the liquid and the corresponding attenuation in passing through the air above the liquid. The basic system for the sorting of perfectly filled from imperfectly filled packages is illustrated. A γ beam is directed through the packages as they pass, one at a time, past a radiation detector. Improperly filled packages provide a much reduced attenuation path (because the path is mostly an air path) and the resulting output signal is much greater than the standard signal. On-off level controls find applications in the process industries. The radioactive source and the detector are mounted on opposite sides of the tank at the critical level. The reduction of signal strength as the contents rise above this level is used for operation of the control relay to shut the valve and stop the passage of further fluid into the reactor vessel. Another method depends on the fact that with liquids containing hydrogen or other low-atomic weight elements, the passage of a fast neutron beam produces an appreciable number slowed-down neutrons. By placing a fast neutron source on one side of the tank and a slow neutron detector on the other side and moving the assembly vertically, the position of the liquid level can be determined. (BBB)

18358 RADIATION PRESERVATION OF FOODSTUFFS. Second Scandinavian Meeting, Stockholm, September 9-11, 1963. Per-Olof Kinell and Vera Runnstroem-Reio, eds. IVA (Ingeniorsvetenskapsakad.) Medd., No. 138(1963), 1-87(1964). (CONF-630906)

Fourteen papers and 4 abstracts of papers presented at the Second Scandinavian Meeting on Food Preservation by Ionizing Radiation are included. Separate abstracts were prepared for 9 papers. Four papers were previously abstracted for NSA and appear as abstracts 18: 3029; 19: 10829, 13009, and 13833. (M.C.G.)

For abstracts of individual papers see: 17567, 18102, 18359, 18360, 18361, 18362, 18363, 18637, and 18638.

18359 IRRADIATION PRESERVATION OF FRUIT JUICES. Helmut Gaisch (Osterreichische Studiengesellschaft fur Atomenergie, Vienna). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138(1963), 9-12(1964).

Experiments are described, which show that the preservation of fruit juices by irradiation is possible. The grape juice and apple juice were irradiated with a dose of 0.5Mrad, kept 24 hr at room temperature, and them warmed for one half hour at 50°C for best results. These juices were kept for 8 months without showing any signs of spoilage. Studies were made of the time dependence of the growth of an irradiated yeast culture. There were indications that the cell life cycle of the yeasts is important with regard to radiation sensitivity. (M.C.G.)

18360 DOSE DISTRIBUTION IN CANS IRRADIATED IN AN ELECTRON LINEAR ACCELERATOR. A METHOD FOR THE DETERMINATION OF DOSE DISTRIBUTION IN CANS AND SOME OF THE PROBLEMS IN OBTAINING AN EQUAL DOSE DISTRIBUTION THROUGHOUT A CAN. Poul-Ivar E. Hansen (Danish Meat Research Inst., Roskilde, Denmark), Elwood F. Reber, and Ari Brynjolfsson. IVA (Ingeniorsvetenskapsakad.) Medd., No. 138(1963), 32-40(1964).

As part of a project to develop sterile canned hams by a combination of a mild heat treatment and a pasteurizing dose of ionizing radiation the dose distribution in cans irradiated in an electron linear accelerator was determined. The cans were filled with layers of agar-agar or ham with intermittent layers of PVC (polyvinyl chloride) which served as dosimeters. After irradiation the films were taken out, heat treated, and the radioinduced colors were recorded. The dose distribution parallel and at right angles to the electron beam was determined. By changing the medium surrounding the cans and by the use of scatter plates conditions were determined for the most equal dose distribution in 2-lb cans. The cans were irradiated from two sides, top and bottom, with 8.8-Mev electrons and the most uniform distribution of dose in the cans was found when scatter plates of copper were used and when the cans during irradiation were completely surrounded by water except for the top of the can, the level of the water being just underneath the lid. The scatter plates were also used in order to compensate for differences in the weight of the cans. Under these conditions it was found that the maximum deviation in the dose in isolated spots of a single can did not exceed 15% of the average dose for all the cans. The results are discussed and it is shown that the second part of the combination process, the heat treatment, does not give uniform distribution of energy. The material at the center of the can gets a milder heat treatment than that at the periphery. It was concluded that it may be advantageous to give an overdose of radiation to the center of the can, rather than looking for an absolute dose uniformity. (auth)

18361 IRRADIATION OF POTATOES. EFFECTS ON SUGAR CONTENT, BLACKENING, AND GROWTH SUBSTANCES. T. A. Trulsen (Danish Atomic Energy Commission, Riso, Denmark). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138(1963), 55-62(1964).

Studies were made of the effects on potato tubers of sprout-inhibiting doses of radiation from a ^{60}Co source. Analyses were made of the sucrose, glucose, and fructose contents up to 7 months after irradiation, and attempts were made to elucidate the effects of various factors on the radioinduced blackening process. The influence of sprout-inhibiting radiation on the content of acid growth-inhibiting substance was also studied, and an attempt was made to reverse the inhibition of sprouting by means of rest-breaking chemicals. After exposure to 8 krad, the sucrose content rose to a maximum during the first few days following irradiation, decreased to normal over a period of 1 to 3 months, and became lower than normal for the rest of the storage period. Only minor variations occurred in the glucose and fructose contents. With the exception of the first months following irradiation, the concentrations of the two sugars were also generally lower in the irradiated than in the untreated tubers. It was found that discoloration in irradiated potato tubers increases with increasing dose, on irradiation in the autumn instead of in the spring, and at intense nitrogen fertilization. The blackening process appeared to be independent of boiling and of the temperature used during the storage period within the range of 5 to 10°C. (M.C.G.)

18362 THE USE OF ULTRAVIOLET RADIATION IN FOOD INDUSTRIES. Torsten Nilsson (Royal Veterinary Coll., Stockholm). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138(1963), 79-82(1964).

The bactericidal effect of ultraviolet radiation is discussed. Disinfection by the use of ultraviolet light is described. Uses of germicidal ultraviolet radiation to reduce surface infection in the baking, dairy, and meat industries are outlined. Chief uses are in the meat industry. Experiments were carried out in which ultraviolet radiation was used in the thawing of deep frozen horse meat and beef. The bactericidal effect was found to be considerable in areas where the ultraviolet radiation was direct. (M.C.G.)

18363 THE INFLUENCE OF GAMMA-IRRADIATION ON SEMIPRESERVED FISH PRODUCTS. Kerstin Abrahamsson (Swedish Inst. for Food Preservation Research (SIK), Goteborg). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138(1963), 83-4(1964).

The use of gamma-irradiation to extend the storage time for semipreserved fish products is discussed. Studies on various canned and smoked fish products are reviewed. For canned fish, results indicated an additive effect of the preservative and low doses of gamma-irradiation. The highest irradiation dose which can be used was found to be 300 krad. Smoked products could, however, tolerate doses up to 500 krad, and this dose considerably increased the shelf life of these products. (M.C.G.)

18364 SIMULTANEOUS VULCANIZATION OF RUBBER BY SULPHUR AND IONISING RADIATION. Z. N. Taraszova, V. G. Kozlov, and B. A. Dogadkin. Magy. Kem. Lapja, 19: 354-9(July 1964). (In Hungarian)

Vulcanization of rubbers under the influence of ionizing radiation was found to result in rise of a peculiar structure with favorable physical-mechanical properties, which can be considerably improved by application of sulfur. A joint thermal-radiation vulcanizing procedure was developed. It was found that the sulfur reacts with rubber at 20°C under the influence of radiation; the amount of sulfur entering into reaction depended linearly on radiation-dose. The reaction rate of sulfur also depended on the temperature of the irradiated mixture. The tensile strength and elongation at rupture of vulcanized rubbers containing sulfur were higher than of those without it. Kinetics and mechanism of crosslink formation are discussed. (auth)

18365 SELECTION OF INSTALLITION AND APPARATUS PARAMETERS FOR RADIOMETRIC TESTING OF CONCRETE. R. Makarov, Y. Basin, and N. Seleznev (Building Physics Inst., Moscow). Nucl. Struct. Eng., 1: 332-7(Mar. 1965).

Methods based on the registration of gamma radiation from concealed sources are discussed. Selection of basic parameters for concrete testing and some problems of radioactive installation and apparatus calibration are considered. (auth)

18366 INDUSTRIAL APPLICATIONS OF RADIO-ISOTOPES. S. C. Ellis (National Chemical Lab., Teddington, Middx., Eng.). Repts. Progr. Appl. Chem., 48: 296-306 (1963).

Activation analysis, measurements with external radioisotope sources, and tracer applications are discussed. (100 references). (M.C.G.)

18367 REPORT OF THE WORKING PARTY ON IRRADIATION OF FOOD. Ministry of Health: Committee on Medical and Nutritional Aspects of Food Policy. London, H. M. Stationery Office. 1964. 85p. 5s. 6d.

After studying irradiation for preserving food, it was concluded that its use does not constitute a hazard to human health. It offers the advantage of prolonging the storage life of food without detriment to wholesomeness. Medical and scientific information on the effects of irradiation on food and the possible hazards to human health were reviewed, and the need to control its use was considered. Recommendations are made that the irradiation of food and food products for human consumption be controlled by means of prohibition, with exemption to be granted under specified conditions. Initially, exemption would be granted after consideration of an application, supported by adequate evidence, in respect of an individual food product treated by radiation in a defined manner. The evidence in support of an application would include: reasons for the proposed irradiation of the food intended for human consumption and the nature of any special group of consumers expected; source, energy, and dose of radiation to be used; nature of the containers in which the food is to be irradiated and stored; proposed conditions and period of storage of the irradiated food; and nature and results of tests for wholesomeness carried out on food irradiated under specified conditions, stored, and then cooked, if cooking is usual before the food is consumed. (BBB)

Power Application

18368 THERMAL POWER OF PROMETHIUM-147. J. C. Posey, R. S. Pressly, and J. H. Gillette (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 21: 403-6(Mar. 1965). (ORNL-P-61)

The thermal power of ^{147}Pm was determined to be 0.414 ± 0.005 w/kC, using calorimetry and 4π beta proportional counting. This value corresponds to an average beta energy of 0.070 ± 0.001 Mev. (D.C.W.)

Separation and Production

See *also* CHEMISTRY — Separation Processes and Procedures.

Refer also to abstract 17856.

18369 DEPENDENCE OF ISOTOPIC EXCHANGE SEPARATION FACTOR ON PROPERTIES OF EXCHANGING MOLECULES. A. M. Rozen and A. I. Mikhailichenko. At. Energy. (USSR), 18: 147-57(Feb. 1965). (In Russian)

The equilibrium constant for isotopic exchange in diatomic compounds was studied as a function of exchanging atom and molecule properties: the power constant, dissipation energy, electronegativity, electron shell structure, intranuclear distance, isotopic mass, and supplementary atoms. Semi-empirical ratios were used for developing analytical equations describing the β-factor effects on the magnitude of equilibrium constants. Correlation methods were used in order to predict β-factor variations in a series of identical compounds. Recommendations are offered for the selection of systems for isotope separation. An attempt was made to expand the obtained data to isotopic exchange in multi-atomic compounds. (tr-auth)

18370 ISOTOPIC ENRICHMENT OF C^{14} BY CHROMATOGRAPHY IN THIN LAYERS. K. V. Viswanathan (CEN, Saclay, France). Intern. J. Appl. Radiation Isotopes, 16: 60-1(Jan. 1965). (In French)

Thin-layer chromatography of sodium formate labeled with ^{14}C gave a radioactive spot at a R_f higher than the inactive spot revealed by bromocresol green. Additional tests made with sodium formate with decreasing specific activity verified the separation of ^{14}C. The results are tabulated. (J.S.R.)

18371 THE ENRICHMENT OF THE STABLE ISOTOPE S^{34} IN THE SYSTEM PYRIDIN/WATER/SULFUR DIOXIDE. G. Stiehl, K. Muehle, and K. Wetzel (Institut für Stabile Isotope, Leipzig). Kernenergie, 7: 836-7(Dec. 1964). (In German)

The incorporation of ^{34}S by the reaction $[\text{pyridine/water}]_n\ {}^{32}SO_2 + {}^{34}SO_2 \rightleftharpoons [\text{pyridine/water}]_n\ {}^{34}SO_2 + {}^{32}SO_4$ is reported. (R.E.U.)

18372 THEORETICAL CONSIDERATIONS ON THE CONTRIBUTIONS OF CHEMICAL REACTIONS TO THE SEPARATION FACTOR OF ISOTOPES. Hidetake Kakihana and Kimiko Kurisu (Tokyo Inst. of Tech.). Nippon Kagaku Zasshi, 86: 151-7(Feb. 1965). (In Japanese)

An attempt was made to achieve the maximum separation factor of isotopes by combination of isotopic effects on the basis of theoretical considerations. It was found that the separation factor of isotopes A and B, S_A^B, can be divided into three terms: $\ln S_A^B \simeq \ln (1 + \epsilon_t) + \ln (1 + \Delta_c) + \ln (1 + \overline{\Delta}_c) \simeq \epsilon_t + \Delta_c + \overline{\Delta}_c \simeq \epsilon_t + \epsilon_c$, where ϵ_t is an effect caused by an isotopic exchange reaction of a certain chemical species between two phases and Δ_c and $\overline{\Delta}_c$ are isotopic effects caused by chemical reactions in the first phase and in the second phase, respectively. The quantity ϵ_c is the sum of the chemical isotopic effects. The mathematical treatments of the sum of the chemical isotopic effects, $\Delta_c + \overline{\Delta}_c$, yielded several conclusions on the favorable combination of chemical isotopic effects to the separation factor. It was concluded that the more the difference in the chemical species is and the more the difference of their concentrations between two phases is, the larger is the contribution of the chemical effects that can be expected. (auth)

18373 CALCULATION OF THE SEPARATION COEFFICIENTS OF ISOTOPES IN AMALGAM EXCHANGE. D. A. Knyazev (Mendeleev Inst. of Chemical Engineering, Moscow). Zh. Fiz. Khim., 39: 40-4(Jan. 1965). (In Russian)

The method of calculation previously proposed (J. Phys. Chem., 35: 612(1961)) was extended to systems consisting of amalgams and an aqueous or non-aqueous solution of an

electrolyte. The coefficients of separation of the isotopes of alkali metals and of three alkaline earth metals were calculated. It is shown that there is a good agreement between the calculated and experimental values for the coefficients. The effects of such factors as the concentration of metal in the amalgam, the nature of the solvent, and the nature and concentration of the electrolyte in the solution were assessed. (auth)

18374 ENRICHMENT OF DEUTERIUM BY A CHEMICAL EXCHANGE PROCESS. Klaus Wetzel (to Veb Vakutronik). Canadian Patent 679,138. Jan. 28, 1964. Filed Apr. 1, 1961.

A process is described that features a high separation factor per stage, thus reducing the number of stages required. Exchange is between a solution of a strong acid in water and a vapor phase in distillation equilibrium with the solution. Counter-current flows and dual-pressure systems may be employed in particular applications. (F.S.A.)

18375 PROCESS AND APPARATUS FOR THE SEPARATION OF GASEOUS ISOTOPES. Walter Dobner. Canadian Patent 682,603. Mar. 24, 1964. Filed June 20, 1961.

This is a process for separating gases based on differences in the speed of molecular diffusion. Typical embodiment involves flow along grooves in the surface of a cylinder which is rotated in a block furnished with appropriately constructed inlet and outlet ports. (F.S.A.)

18376 PROCESSES AND APPARATUS FOR PREPARING HEAVY WATER BY ISOTOPIC MONOTHERMIC AMMONIA—HYDROGEN EXCHANGE. Bertrand Lazard (to Commissariat a l'Energie Atomique). Canadian Patent 701,780. Jan. 12, 1965. Priority date Dec. 14, 1960, France.

An improvement was made in the isotopic monothermic ammonia–hydrogen exchange process. Catalyst reinjection circuits were added so that the ammonia flows in closed cycle. Flowsheets show the rather complex circulation between the (chemical) reactor assemblies and evaporators. More efficient use of the catalyst is claimed. (F.S.A.)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 18626 and 19319.

18377 (CONF-650304-1) YATES ALGORITHM AND PROGRAMMING THE ANALYSIS OF VARIANCE OF FACTORIAL EXPERIMENTS FOR DIGITAL COMPUTERS. A. S. Covert (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract [W-31-109-eng-52]. 15p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

From General Electric Statistics Workshop Meeting, New York.

Yates algorithm is described. Its advantages as a basis for programming are noted. Certain decisions and auxiliary algorithms required for a program are discussed. (auth)

18378 (EUR-2171.i) CALFUGEN. G. P. Caligiuri European Atomic Energy Community, Ispra (Italy) Joint Nuclear Research Center and European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center). Nov. 1964. 31p. Dep.(mn).

CALFUGEN (CALcul FUnctions GENeration) is a special FORTRAN program: together with APACHE it permits automatic programming and setting up of arbitrary continuous functions of one variable on analog computers. It makes use of normal linear and nonlinear operational components such as potentiometers, amplifiers and multipliers. CALFUGEN input data are numerical values of the given function at fixed points of a finite interval. Several approximations were studied to fit a suitable curve to n + 1 data points. Lagrange polynomial interpolation proved to be among the best of those suitable to be generated on analog computers, permitting also simple extension to relatively high order curves. CALFUGEN output data are parameters, variables, and equations acceptable to APACHE code which automatically provides all information necessary for treatment on analog computers, for any Lagrange polynomial of order up to the 9th and for any input. This method of generating functions for the first time makes simultaneous use of both FORTRAN and APACHE. It provides a new subroutine for APACHE and gives rise to functions with good accuracy by simple means. (auth)

18379 (LA-DC-6351) A VECTORIAL SUBDIVISION FOR SPACIAL INTEGRATION OF FUNCTIONS WITH CUBIC SYMMETRY. W. C. Overton, Jr., and A. F. Schuch (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1963]. Contract [W-7405-eng-36]. 22p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

A scheme is devised for subdividing the irreducible trihedral angle determined by the highest cubic symmetry into elemental tetrahedral (or trihedral) cones, each of which subtends a solid angle of $(4\pi/48)$ (1/489) steradians. The centroid of the solid figure formed by each cone and the surface cut by it on a sphere is located. The direction cosines of the 489 vectors through these centroids are tabulated to ten decimals. The IBM 7030 (STRETCH) was used for the calculations. Numerical spatial integrations employing the new subdivision are greatly simplified, since separate weightings of the functions evaluated on each vector are not required. (auth)

18380 (KAPL-M-6433) GALS4—GENERAL ANALYSIS OF LINEAR SYSTEMS. Gerhard O. Mueller and James A. Warrington (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 15, 1964. Contract W-31-109-eng-52. 68p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

GALS4 is a general linearized feedback systems analysis program based on the LaPlace transform. It is written in the FORTRAN-IV language for the Philco 2000 digital computer. The transfer functions which comprise the various blocks of the control system must be represented as polynomial fractions $(P_1(s)/P_2(s))$ and fed into the program. The program will calculate the equivalent system polynomial fraction (Block diagram reduction), the frequency response (Bode and Nyquist coordinates), Root Loci data, and the transient response for a system described in transfer function notation. The four sections may be used independently or in combination at the user's option. The running time of a normal system may vary from one to six minutes depending upon the complexity of the problem. (auth)

18381 (KAPL-M-6436) STAT-1—AN INTERPRETIVE PROGRAM FOR STATISTICAL CALCULATIONS. R. W. Guillette (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 21, 1964. Contract W-31-109-eng-52. 17p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

STAT-1 is a collection of seven separate statistical routines in the form of an interpretive program. The program performs its operations on data presented in matrix form. A limitation imposed by the program is that the row length of any matrix not exceed 700. STAT-1 is written in a manner whereby it is possible to call its routines interchangeably with the commands available in STAT-3. STAT-1 was written primarily to reduce data from various material scanning instruments presently in use at KAPL. It is possible, however, to perform the calculations available on any data presented in matrix form. STAT-1 will ultimately become a part of the SCAN data processing system. (auth)

18382 (ORNL-3742) A GENERALIZED ONE-CONSTRAINT LAGRANGE MULTIPLIER NUMERICAL FORMULATION. F. H. S. Clark and F. B. K. Kam (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 40p. Dep.; $2.00(cy), 1(mn) CFSTI.

The one-constraint Lagrange multiplier problem has been written for the CDC-1604 computer in a FORTRAN program called MAX. The program can deal with a combination of any varied and any constraining function which depend on no more than 18 independent variables and for which all second derivatives exist throughout the domain. The user is required to write two subroutines: one defines the varied function, the other, the constraining function. The computational method used is absolutely nondivergent, but for some starting values in some problems it will stop in the neighborhood of an extraneous point and require a restart at a different point. A test problem is included. (auth)

18383 (TID-21595) ICR QUARTERLY REPORT NO. 1, MAY 1, 1964. Nicholas C. Metropolis (Chicago Univ., Ill. Inst. for Computer Research). Contract AT(11-1)-614. 136p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Progress is reported in the Maniac III project, on research studies directly related to the use of computers, and on investigations in other applications areas. The work is summarized in sections on the Maniac III desk file system, function evaluation subroutines for Maniac III, and spark chamber information retrieval. Information is included on a meeting on spark chambers at CERN. Progress is also reported on Algal 60 compiler development. An algorithm is described for non-restoring decimal division in variable word-length character-oriented machines. A method for binary-decimal conversion of unnormalized numbers is discussed along with the possibilities for error control afforded by unnormalized arithmetic in the context of polynomial manipulation. Results of a study concerning a class of recurrence relations in the context of unnormalized arithmetic is included. Other sections are on investigations in numerical analysis, iterative procedures, learning and pattern recognition, evaluation of learning models, and computer applications in astrophysics, nuclear physics, and business. (J.R.D.)

18384 (UCRL-7779) A NUMERICAL METHOD FOR GENERATING THE COEFFICIENTS OF $f = (X + X^2 + \ldots + X^m)^n$. Grover M. Taylor (Lawrence Radiation Lab., Univ.

of California, Livermore). Mar. 24, 1964. Contract W-7405-eng-48. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A numerical routine for generating all the coefficients of the expansion of the function $(X + X^2 + \ldots + X^m)^n$ is described. The routine requires only addition and subtraction of whole numbers. A problem of the complexity of $m = 6$, $n = 5$ can be completely solved in a few minutes using pencil and paper. The routine may have applications in the solution of more complex problems since a program for use of a digital computer would be relatively uncomplicated. (auth)

18385 (UCRL-12294-T) COMPUTERS IN THE U.S.A.—TODAY AND TOMORROW. S. Fernbach (Lawrence Radiation Lab., Univ. of California, Livermore). Jan. 4, 1965. Contract W-7405-eng-48. 25p. (CONF-650505-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From IFIP Congress 1965 Meeting, New York.

Digital computers have proliferated in the country over the past 15 years, such that at present there are many thousands of them, large and small, totaling approximately 4 billion dollars in value. The small ones of today are far more capable and less expensive than the large ones of yesterday. One of the problems facing computer users is that of choice of equipment for future use. With the speed of the new systems so great that most problems consume very little time, the user has to decide whether he should put his money in one very large, capable machine or into a large number of smaller computers dealing with these problems in a parallel mode. If a parallel processor is the machine of the future, it is not clear at present how one writes systems for it, or how one distributes the work for it. Much effort will be necessary to determine how such computers, hardware, and software, should be built and used efficiently. (auth)

18386 ANALYSIS OF EXPERIMENTS IN PARTICLE PHYSICS. Frank T. Solmitz (Univ. of California, Berkeley). Ann. Rev. Nucl. Sci., 14: 375-402(1964). (UCRL-11413)

Basic laws of probability and statistics and of mathematical induction are reviewed for application to data analysis in particle physics. Properties of some distributions, including multinomial, Poisson, normal, and χ^2 distributions, are summarized. The Bayesian and anti-Bayesian approaches to estimation of parameters are discussed. The method of least squares is described, and the analysis of angular distributions is considered. (M.J.T.)

18387 GAMMA-RAY SPECTRA ANALYSED BY COMPUTER PROGRAMME USING THE PEAK AREA METHOD. S. C. Choy and R. A. Schmitt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nature, 205: 758-60 (Feb. 20, 1965).

A computer program was formulated that is now used routinely in the instrumental neutron activation analysis of meteorites. In particular, the problem involves the determination, via instrumental neutron activation analysis, of the abundances (or concentrations) of selected chemical elements in meteorites and separated meteoritic minerals and chondrules, etc. To calculate the concentration in ppm, the following items are included in the computer formulation: quantities of the specimen and reference standards expressed in g and μg units, respectively, and duration of counting and median counting times for specimen and standard, respectively. The printed result in ppm also includes the standard deviation due to counting statistics. The mathematical formulation of the computer program is given. (P.C.H.)

18388 STABILITY OF MOTION. Applications of Lyapunov's Second Method to Differential Systems and Equations with Delay. N. N. Krasovskii. Translated by J. L. Brenner from "Nekotorye Zadaci Teorii Ustoicivosti Dvizeniya." Stanford, Calif., Stanford University Press, 1963. 192p. $6.00.

A rigorous analysis is given, extending the work of Lyapunov and applying his direct method to a variety of problems. Lyapunov's theorems on asymptotic stability and instability are generalized. Problems of mth-order stability and persistent disturbances are explored. General results are established for differential systems with and without delay. 202 references. (M.J.T.)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstract 18197.

18389 (BNL-906) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 2, No. 6. Dec. 1964. (Brookhaven National Lab., Upton, N. Y.). Feb. 1965. 37p. Dep.; $2.00(cy), 1(mn) CFSTI.

A total of 16 reviews are presented of progress reports and other publications on liquid-metal research. Tables are included which list current liquid-metal research and development in physical properties, heat transfer, and corrosion. (D.L.C.)

18390 (GEMP-43A) HIGH-TEMPERATURE MATERIALS PROGRAM. Progress Report No. 43, Part A. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Jan. 29, 1965. Contract AT(40-1)-2847. 78p. Dep.; $3.00(CFSTI).

Laboratory testing of Fe–Cr–Al–Y-clad Cr–UO_2 and Fe–UO_2 capsule specimens was continued at 950, 1100, and 1250°C in air with goals of 10,000 hours. Metallographic analyses of the 2541-alloy-clad Fe–50UO_2 system after 5035 hours at 930°C showed no evidence of instability, and electron microprobe analyses showed no evidence of U diffusion into the cladding within the limits of sensitivity (500 ppm). The first prototype in-pile specimen of 2541-clad Fe–40UO_2 proof-tested at 1100°C for 500 hours exhibited excellent stability. Impact tests of various Fe–Cr–Al-base alloys indicate that 1 wt % Y additions raise the ductile-to-brittle transition temperature by about 150°C. Both annealed and aged specimens of 1541 alloy irradiated to 10^{19} nvt ($E_n \geq 1$ Mev) showed slight increases in hardness which were readily removed by annealing at 300°C. Corrosion testing of various compositions of Fe–Cr–Al–Y alloys continued in both air and superheated steam at 450 to 1100°C for times up to 4000 hours. Alloys of lower Y and Cr contents exhibit less weight gain in 900°C air. Creep-rupture results of arc-cast 0.15-cm-dia Mo rods at 2200°C in H_2 were the same as obtained for 0.025-cm sheet material. This indicates that the creep-rupture strength of arc-cast Mo is not affected by surface-to-volume ratios from 25 to 190. The stress-rupture life of arc-cast W at 2200°C agrees reasonably well with data obtained from two sources of wrought powder-metallurgy material; however, the linear creep rate is greater for the arc-cast material. Ta exposed to H_2 for 1 hour at 600 or 800°C and tensile tested at the same temperature decreased in both ductility and strength as compared with room-temperature properties. Pretreatment in vacuum at 2200°C prior to exposure to H_2 at 600°C for 1 hour reduced the tensile ductility to 2% elongation. Room-temperature bend ductility test results disclosed that W–30Re alloy age-hardens at 1200 to 1600°C. Twelve new W–Re–Mo alloys were processed to define compositions developing the maximum aging response and compositions showing no hardening reactions. Hot swaging of Mo-encapsulated W–Re–Mo alloys proved to be superior to secondary extrusion operations in obtaining small diameters for cold drawing. Creep rupture testing at 900°C (0.32 T_m) of irradiated (8.2×10^{19} nvt at reactor ambient temperature) W specimens shows that the as-irradiated and the irradiated plus annealed specimens have a significantly longer rupture life than the unirradiated specimens. A 1- and 34-hour anneal at 1700°C resulted in estimated times to rupture at 900°C which are a factor of 25 and 8.7, respectively, greater than that of a control specimen. As noted in previous tests, ductility was not significantly affected as a result of irradiation at reactor ambient temperatures. Creep-rupture data of irradiated Mo specimens tested at various temperatures indicated an acceleration of the creep rate in the temperature region of about 580°C (0.30 T_m). Above and below this temperature region, the effect is not as great. This creep acceleration effect was noted in specimens irradiated to fast neutron doses of 1.0×10^{19} and 3.7×10^{19} nvt. By synthesizing a series of alloys representing the transmuted composition of W and W–25Re, possible transmutation effects on the thermoelectric output in the W/W–25Re thermocouple system after 0.5, 1, 3, and 6 months at 10^{14} thermal neutron flux were identified. Pure Ru was evaluated for emf output and temperature sensitivity to determine if its thermoelectric characteristics are adequate for operating in reducing on inert gas environments at 1200 to 1600°C. Preliminary tests were conducted to determine the effect of O_2 partial pressure on the measured electrical resistance of ThO_2. By varying the dewpoint of H_2 gas surrounding a ThO_2 resistivity sample, the electrical resistance at 1800°C was rapidly increased from 18 ohm-cm to 70 ohm-cm. (auth)

18391 (HW-SA-3483) MAJOR ACCOMPLISHMENTS OF HANFORD LABORATORIES IN PLUTONIUM FUELS DEVELOPMENT. G. M. Dalen (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 21, 1964. Contract AT(45-1)-1350. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A survey is presented of the major accomplishments of the plutonium power fuels development program during the past 7 years. The accomplishments include packed-particle fuel elements, vibrational compaction, swage compaction, pneumatic impaction, Pu–Al alloy fuels, fuel irradiations, unsegmented fuel rods with spirally wrapped spacer wires, magnetic-force resistance welding, and quality and process control. (D.L.C.)

18392 (LA-3183) METALLOGRAPHIC AND ELECTRON MICROSCOPIC EXAMINATIONS OF FLUORIDE FILMS ON URANIA. W. P. Ellis and Dana L. Douglass (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Sept. 1, 1964. Contract W-7405-eng-36. 51p. Dep.; $3.00(cy), 1(mn) CFSTI.

Metallographic and electron microscopic examinations have revealed characteristic features of the interference films of uranium tetrafluoride formed on the flat surfaces of macrocrystalline uranium dioxide by reaction with gaseous anhydrous hydrogen fluoride. At reaction temperatures in the interval 200-300°C the product films are isotropic and uniform in color although the surface itself has topographical details. Above 300°C there is a progressive formation of blemishes with degradation beginning first at roughness sites in the substrate and apparently spreading to include the entire surface. For reactions at 400°C and below there are no specific features in the replicas to correlate with the blemishes. All of the structures seen in the replicas of the reacted specimens are also seen in replicas of the substrate. At 463°C, however, the film is covered with ruptures visible with the electron microscope. (auth)

18393 (ML-TDR-64-173(Pt.II)) HIGH-TEMPERATURE PROTECTIVE COATINGS FOR GRAPHITE. J. M. Criscione, R. A. Mercuri, E. P. Schram, A. W. Smith, and H. F. Volk (Union Carbide Corp., Parma, Ohio. Carbon Products Div.). Aug. 1964. Contract AF33(657)-11253. 154p. CFSTI.

A comprehensive program to provide fundamental information concerning various factors controlling the oxidation behavior of protective coating systems for graphite at temperatures up to 2200°C is outlined and described. Work presented includes: the evaporation of iridium in the presence of oxygen and water vapor to temperatures of 1300°C; the results of studies involving carbon diffusion through iridium; the permeability of iridium, rhodium, ZrO_2, HfO_2, and ThO_2 to oxygen at temperatures of 2000°C; the coating of graphite with iridium, including the carbon iridium

eutectic temperature determination; the reactions of iridium and rhodium with ZrB_2, HfB_2, ZrC, HfC, and ThC_2; the kinetics of the carbothermic reduction of ZrO_2, HfO_2, and ThO_2 to temperatures in excess of 2000°C; the chemical reactions of graphite with ZrB_2 and HfB_2; and arc plasma tests of iridium-coated graphite. The diffusivity, permeability, and kinetic data are presented in the form of mathematical expressions. A mechanism for the diffusion of oxygen through the refractory oxides based on ion vacancy transport is presented. The chemical kinetics for the carbothermic reductions of the oxides are described by linear rate laws for the initial 50 per cent of the reaction. The experimental results are also discussed as to their practical implications to oxidation protective coatings. (auth)

18394 (ML-TDR-64-294) DEVELOPMENT OF PROTECTIVE COATINGS FOR TANTALUM-BASE ALLOYS. TASK II. DEVELOPMENT OF TECHNOLOGY APPLICABLE TO COATINGS USED IN THE 3000 TO 4000°F TEMPERATURE RANGE. B. Ohnysty, O. M. Stansfield, A. R. Stetson, and A. G. Metcalfe (Solar, San Diego, Calif.). Jan. 29, 1965. Contract AF33(657)-11259. 103p. (RDR-1360-10). CFSTI.

The objective of this program was to develop new concepts and obtain experimental data which would be useful in a solution to the problem of the protection of tantalum from oxidation in the 3000 to 4000°F temperature range. Studies of bulk oxides were made to determine what modifier oxides would be required to form the optimum oxide coating. Thermal expansion measurements were performed on oxides from 1500 to 4000°F to determine the expansion match with tantalum. Electrical conductivity of an oxide was used as one indication of the fission characteristics of an oxide, hence its protective ability. Compatibility tests were also conducted with oxide, reservoir, barrier, and substrate material. The experimental results indicate that hafnia or hafnia modified with ZrO_2 and Y_2O_3 are suitable for continued investigation as coating materials. Hafnium appears to be a suitable reservoir material with tungsten as a barrier on tantalum. (auth)

18395 (NASA-TN-D-2688) IMPROVED CERAMIC-BONDED CALCIUM FLUORIDE COATINGS FOR LUBRICATING NICKEL-BASE ALLOYS IN AIR AT TEMPERATURES FROM 500° TO 1700°F. Harold E. Sliney (Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio). Feb. 1965. 16p. $1.00(CFSTI).

This study was conducted with the objective of developing modifications in coating procedure and composition that would improve the lubricating characteristics of ceramic-bonded calcium fluoride (CaF_2) coatings. The lubricating properties of these coatings were strongly influenced by the details of the coating application procedure. Of particular importance were: thorough wet-grinding (pebble milling) of CaF_2 and the ceramic binder, the use of a very fine spray when applying the milled material to the substrate, and careful control of firing time and temperature when fusion-bonding the coating to the substrate. A 3 percent addition of molybdic oxide (MoO_3) to the coating composition and the application of a rubbed film of a fluoride eutectic composition (62 percent barium fluoride–38 percent calcium fluoride) were beneficial. Improved performance at 1000°F was also obtained by initially running the specimen at 1500°F to establish a glazed wear track. Common factors in all beneficial modification were (1) a reduction in the porosity of the coating and (2) an improvement in the homogeneity of CaF_2 dispersion throughout the ceramic binder. (auth)

18396 (ORNL-3764) STUDIES ON EFFECTS OF DEPOSITION CONDITIONS AND HEAT TREATMENT ON THE PROPERTIES OF PYROLYTIC CARBON. Ji Young Chang (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 90p. Dep.; $3.00(cy), 2(mn) CFSTI.

Thesis submitted to Univ. of Tennessee, Knoxville.

A study was made of the deposition of pyrolytic carbon from methane gas on direct resistance-heated graphite substrates; the deposits were characterized by means of density, crystallite size, preferred orientation and magnetic susceptibility measurements, and by microstructure studies. The effect of deposition conditions and heat treatment were evaluated in terms of anisotropy factors derived either directly from experimental susceptibility data or indirectly through calculation from other measurements. Deposits up to one millimeter thick were formed over the temperature range 1400 to 2400°C with subsequent heat treatment conducted at 2620°C for times up to 360 minutes on material deposited at 2200°C. All deposits had a columnar, cone-shaped grain structure perpendicular to the deposition surface. The crystallite size, degree of preferred orientation, and density increased and the unit cell height decreased with increasing deposition temperature and heat-treatment time. Evaluation of a diamagnetic susceptibility anisotropy factor, as the ratio of the diamagnetic susceptibility in the direction perpendicular to the deposition plane to the value measured in the plane, showed an increase in the value of this ratio for pyrolytic carbon deposited at progressively higher temperatures and heat treated for longer times. When the value of this direct experimental factor was compared to several calculated factors from x-ray and single-crystal susceptibility values, it was found that the calculated values were too high in every case involving as-deposited material. This behavior was interpreted as indicating that the calculations should not be made, assuming that single-crystal values for the susceptibility are correct, but rather that values characteristic of the state of imperfection of the individual crystallites in the deposit should be used. Since these data were not available, a reverse calculation was made to determine the ratio of the diamagnetic susceptibility in the c-plane to that perpendicular to the c-plane of the crystallites of each deposit. This calculated ratio was considerably higher than calculated from data for the best single crystals but did decrease toward the single-crystal value as the deposition temperature was increased. (auth)

18397 (RL-SEP-30) CONTINUOUS ELECTROWINNING OF PLUTONIUM METAL. Progress Report. M. H. Curtis (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 1964. Contract AT(45-1)-1350. 103p. Dep.; $4.00(cy), 2(mn) CFSTI.

Continuous electrowinning of plutonium metal from a molten chloride system was demonstrated by a program involving nearly 100 runs. Continuous runs over 10 hr in length were made in equipment with a favorable nuclear geometry. Currently the process produces 50 g of plutonium per hour, with a cathode current efficiency of 60%. The process operates at 800°C and is contained in a 2 in. diameter cylindrical system. The basis for continuous operation is the cell, a two-piece ceramic oxide body that forms an annular container with a bottom weir. The best tested is a slip cast magnesia-10% titania body. It was shown that it is possible to operate this process reliably on a one-shift basis. Electrochemical problems have arisen and were generally solved. Quality specifications for the plutonium chloride feed were partially established, and the process was shown to have a capability of handling oxide in partly chlorinated feeds. Product contamination by corrosion products was considered in selecting materials of construction. Equipment configurations were improved to increase container reliability and electrochemical efficiency. Apparatus of this geometry and scale is reasonably safe from the nuclear standpoint. (D.L.C.)

18398 (RPI-2408-1) STUDIES OF SINTERING. Annual Report. Fritz V. Lenel (Rensselaer Polytechnic Inst., Troy, N. Y.). Feb. 1965. Contract AT(30-1)-2408. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The purpose of this project is to study the mechanism of materials transport during sintering of crystalline solids. An experiment was completed, in which the sintering of a silver sphere to a silver plate under an applied external load at temperatures in the range of 800°C was investigated. It was found that the dependence of strain rate (rate of increase in neck area between sphere and plate) upon stress changes rapidly in the stress range from 6 to 60×10^{-5} dynes/cm^2. At low stresses the strain rate approaches proportionality to stress; at high stresses it is proportional

to the 4.5th power of the stress. This indicates that the material transport mechanism changes from one of Herring–Nabarro microcreep to one by dislocation motion controlled by dislocation climb. A similar experiment on the sintering of calcium fluoride is now under way. In this case the type of material transport is to be determined by observing whether a finely divided inert second phase in the calcium fluoride moves with the matrix material or not during a model experiment. In a supporting experiment, the sintering together of three silver wires containing finely distributed markers is to be studied. The stress due to surface tension in the sintering of a model consisting of two spheres as a function of increasing neck radius and of approach between the centers of the spheres is being calculated using a computer. (auth)

18399 (TID-21513) SPECIFICATION FOR THE PROCUREMENT, STORAGE, AND APPLICATION OF ROOM-TEMPERATURE-CURING SILICONE RUBBER, SILICONE RUBBER FOAMS, SILICONE PRIMERS, ADHESIVES AND SEALANTS. Harry F. Jensen (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Mar. 11, 1960. Contract AT(45-1)-1350. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Specifications are presented for silicone rubber materials and sealants and the necessary primers and catalysts for use in sealant applications at Hanford. The specifications pertain to the material identity, packaging, and storage. Information on the applications is also given. (D.L.C.)

18400 (TID-21663) PREPARATION AND EVALUATION OF DISPERSION-STRENGTHENED IRON–ALUMINUM–CHROMIUM ALLOYS. Annual Summary Report. Blake King and H. A. B. Wiseman (Miami Univ., Coral Gables, Fla. Mechanical Engineering Dept.). Oct. 29, 1964. Contract AT(40-1)-3153. 69p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Eleven experimental alloys were prepared by extruding aggregates of surface-oxidized master-alloy powders. The materials contained 5 to 10 vol % oxide in matrices made up of 7 to 10 wt % Al and around 5 wt % Cr in iron. Three of the alloys contained a 3 wt % Mo addition. The design of the alloys and the methods used in producing them were based on the results of a previous program in which two excellent materials were made which exhibited stress-rupture properties at 870°C better than those of Type 316 stainless steel, and which were exceptionally oxidation resistant. Only one of the new alloys, however, gave evidence of containing an effective dispersion, and it was inferior in both high-temperature strength and oxidation resistance to the best of the old materials. The poor quality of the new alloys is tentatively ascribed to the fact that the oxide phase in them is in the form of large particles coarsely and unevenly dispersed in the matrix. It appears that a coalescence or agglomeration of the oxide took place when the powder compacts were heated prior to extrusion. (auth)

18401 (WANL-PR(Q)-005) DEVELOPMENT OF DISPERSION-STRENGTHENED TANTALUM-BASE ALLOY. Fourth Quarterly Progress Report, August 20, 1964–November 19, 1964. R. W. Buckman, Jr. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Contract NAS 3-2542. 28p. (NADA-CR-54288; N65-17199)

Development of dispersion-strengthened tantalum-base alloys for use in advanced space power systems continued with the tentative selection of three compositions which will be melted as 4 inch diameter ingots. Continuing investigations of response to heat treatment has shown that Ta–W–Zr–N and Ta–W–Mo–Re–Zr–N alloys are age hardenable systems which show promise for use as turbine materials. A procedure for the addition of nitrogen to first melt electrodes has been established. (auth)

18402 (WCAP-3269-29) METALLURGICAL EVALUATION OF SILVER–INDIUM–CADMIUM CONTROL ROD ALLOYS. W. R. Smalley and D. B. Scott (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Aug. 1964. Contract AT(30-1)-3269. 36p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Tin, platinum, and palladium have been evaluated as alloying additions to the basic 80% silver–15% indium–5% cadmium alloy in an effort to improve mechanical properties and corrosion resistance. It was found that a combined addition of 2.5% Pd and 0.5% Sn was the most effective in increasing elevated temperature yield and creep strengths, and in improving the resistance to internal oxidation in hot borated water. Experiments run to determine the relative effects of irradiation on the basic Ag–In–Cd and a 0.5% Sn modification showed that the ternary alloy was more resistant to irradiation-induced changes in mechanical properties and dimensions. Extended exposure of Ag–In–Cd specimens at 725°F, both in an inert atmosphere and in steam, showed that the alloy was dimensionally stable under the most severe temperature and environmental conditions expected in service. (auth)

18403 (JPRS-28165) RARE EARTH CERMETS. G. V. Samsonov. Translation of p.53; 59-62; 88-92; 112-14; 170; 185; 214-15; 224; 239-40 from "Tugoplavkie Soedineniya Redkozemel'nykh Metallov s Nemetallami," Moscow, 1964. 25p. (TT-65-30076). $1.00(CFSTI).

A review is presented of preparation methods and uses of rare earth borides, carbides, nitrides, silicides, and sulfides. Individual bibliographies are included. (D.L.C.)

18404 HIGH-FREQUENCY INDUCTION HEAT TREATMENT OF METALLIC URANIUM. Kiichi Kawashima (Furukawa Electric Co., Ltd., Japan). FAPIG (Tokyo), No. 29, 276-82(Dec. 1963). (In Japanese)

The so-called β treatment, which involves quenching or transformation of the β phase to the α phase, is known as an effective procedure to improve the structure of uranium fuel elements in orientation and grain size. Tests were conducted on the β treatment of a uranium bar in a testing apparatus, which consisted of a high-frequency generator, a high-frequency output controlling gear, a transformer, high-frequency quenching device, and a device for the temperature measurement and recording. The results showed that a solid cylindrical uranium bar of 27 mmϕ, and a hollow cylindrical uranium bar of OD 42 mm and ID 23 mm can be β treated effectively in the apparatus using 3000 cycles per second. The heating obtained by high-frequency induction is uniform after the thermal equilibrium and so long elements can be treated. The high-frequency induction heating is effective in the β treatment. The structure of an element after β treatment by high-frequency induction heating is more fine and homogeneous than that obtained by the conventional β treatment using a salt bath. (Nucl. Sci. Abstr. Japan, 3: (Nov. 1964))

18405 PREPARATION AND APPLICATION OF HIGH PURITY METALS AND INTEGRAL DOMAIN OF MODERN TECHNIQUE. Gyozo Varhegyi. Magy. Kem. Lapja, 19: 439-46(Aug. 1964). (In Hungarian)

Definition of the concept of high-purity metals and their designation are discussed. The methods of chemical and physical analysis serving for definition of purity are reviewed. After a systemized survey of preparation methods some properties and fields of application of high-purity metals are discussed. (auth)

18406 ARC PLASMA IN POWDER METALLURGY. A. P. Krasnov and V. M. Sleptsov. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 1, 79-86(Jan. 1965). (In Russian)

A survey is given of data on the plasmotron and on the use of the arc plasma in powder metallurgy. Use of plasma for the synthesis of some refractory compounds (carbides, nitrides) is discussed. Some data are also presented on the use of plasma for synthesis of refractory compounds, for obtaining spherical powders, and for dusting of refractory materials on metals. (auth)

18407 EXOTIC METALS 1965. Robert N. Rickles. Chemical Process Monograph Series No. 5. Pearl River, N. Y., Noyles Development Corp., 1965. 124p. $20.00.

Technical and economic studies of the chemical processing of the exotic metals, Ti, Zr, Mg, Nb, Ta, Mo, W, and Be are presented. Marketing, history, procedures and prices, geology and raw materials, principal production methods, properties, fabrication, applications, and future prospects are discussed for each method. (M. C.G.)

18408 A NEW TECHNIQUE FOR HIGH PURITY METALLURGICAL PROCESSING. F. Pagano and D. W. Jones (Aero Vac Corp., Troy, N. Y.). 21p. (CONF-603-9)

From Transaction of Meeting, Vacuum Metallurgy, American Vacuum Society, New York, June-July 1964.

The mechanics of a process are described, which uses controlled, flowing atmosphere to provide a test volume with a high-purity environment. The superiority of this process over standard techniques is its ability to achieve low impurity pressures at a minimum of gas flow and equipment cost. The sources of contaminant gases were studied. Such factors as surface migration, container outgassing, and tube outgassing were all investigated analytically. It was found that a region of extremely high-purity gas could be obtained, governed mainly by the purity of the inlet gas and the total operating pressure. A furnace was designed to test the system. A gas flow rate of 2 atm-cm^3/sec resulted in an impurity concentration of less than 10^{-6} torr in the test area while the contaminant gas pressure was 1 torr. Nb–1% Zr alloy samples were exposed to the environment for approximately 10 days. The contamination pickup corresponded to a vacuum of 10^{-6} to 10^{-7} torr. (auth)

Corrosion

Refer also to abstracts 17774, 18051, and 19391.

18409 (COO-1000-1) A STUDY OF THE OXIDATION OF ZIRCONIUM–NIOBIUM ALLOYS IN THE TEMPERATURE RANGE 300°–500°C. Final Technical Report. Otto Zmeskal and Kuang-Hui Lin (Toledo Univ., Ohio. Research Foundation). Mar. 3, 1965. Contract AT(11-1)-1000. 68p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The kinetics and mechanism of oxidation and zirconium and zirconium-niobium alloys were investigated at 400, 500, and 600°C in the oxygen stream of the pressure range 1-760 torr for time periods up to 100 hours. The oxidation rate measurement was made by a continuous gravimetric method. Photomicrographs and electron micrographs of the cross section of the oxide-metal interface and the oxide surface were taken in order to study the structure and development of oxide films. It was found that the oxidation behavior of the materials was governed by whether the specimen had been subjected to "degassing" prior to oxidation measurement. The "degassed" zirconium specimen exhibited a characteristic rate curve which could be divided into three distinct sections. A horizontal transition region, representing a negligible rate of reaction, always appeared in the middle section of the curve. The length of this transition region becomes progressively shorter with increasing oxygen pressure. The electron micrographs supported the presumption that the presence of the horizontal transition region can be ascribed to the formation of some protective oxide film. The shapes of the reaction rate curves for the "degassed" alloys varied widely with the composition, temperature, and pressure. The "un-degassed" zirconium at both 500 and 600°C, and 760 Torr pressure oxidized according to approximately parabolic relationship. The activation energy between 500 and 600°C was 21.8 kcal/g-mole. The oxidation of the "un-degassed" alloys proceeded almost linearly with time. The influences of oxygen pressure and temperature on the oxidation of zirconium and zirconium alloys were appreciable, but the nature of pressure effect was rather complex. The photomicrographs supported the kinetic data to show that alloying of niobium with zirconium increased the reactivity of the material toward oxygen. (auth)

18410 PROCESSES TAKING PLACE ON THE PHASE INTERFACE TUNGSTEN | GAS AT HIGH TEMPERATURE. CORRELATION OF THESE PROCESSES WITH THE CORROSION OF TUNGSTEN. A. J. Hegedus (Forschungsinstitut fur die Nachrichtentechnische Industrie, HIKI, Budapest). Acta Chim. Acad. Sci. Hung., 42: 305-16(1964). (In German)

Processes taking place in the phase interface of tungsten and a gas, which are of prominent importance from the aspect of conductance measurements carried out with tungsten electrodes at high temperature, were investigated. Tungsten metal was coated in air by a corrosion layer, which was removed by the first ignition beginning from 800°C. The strength of positive emission currents, generated at about 1000°C during this process under given experimental conditions, depended on the thickness of the corrosion layer and on the time of contact of the layers with O_2 and H_2O, and on the value of p_{O_2} and p_{H_2O}, respectively. The removal of the corrosion layer affected the conductivity behavior of the substance in contact with the tungsten electrode, and the lifetime of incandescent lamps with tungsten filaments. On the basis of data in the literature, other sources of failure are mentioned, which occur when tungsten electrodes are applied for the investigation of the mechanism of conductance of solid substances carried out with the use of tungsten electrodes. (auth)

18411 CONTRIBUTION TO THE DECOMPOSITION OF OXIDE BLOCKING FILMS ON ALUMINUM AND TANTALUM SURFACES. G. Hahn. Acta Tech. Acad. Sci. Hung., 45: 443-53(1964).

Corrosion protection oxide films, which consist partly of nonoxidized metallic ions that gradate to higher concentrations adjacent to the base metal, were studied. The failure mechanism was found to be the result of capacitive action and penetration of the boundary zone by these ions, loosening the oxide blocking film structure. The distribution of the metal ion particles was different for Al and Ta. (Rev. Metal Lit., 22: (Jan. 1965))

18412 BREAKAWAY PHENOMENA IN THE OXIDATION OF ZIRCONIUM AT 850 AND 950°C. G. R. Wallwork, C. J. Rosa, and W. W. Smeltzer (McMaster Univ., Hamilton, Ont., Can.). Corrosion Sci., 5: 113-20(Feb. 1965).

An investigation was made on the deviations from parabolic oxidation kinetics to more rapid rates for zirconium at 850 and 950°C. Stresses in the oxide and in metal containing oxygen in solid solution induced cracks in both phases and permitted increased localized oxidation. Small voids were observed at the metal/oxide interface in metallographically prepared sections of oxidized specimens and a duplex scale was formed by cracking between these voids. A distinctly different type of scale was produced where the metal was cracked. Growth of this type of scale could also be induced by injecting small amounts of water vapor in the oxygen atmosphere and resulted in catastrophic failure of the specimens. (auth)

18413 OXIDATION OF CARBONS AND GRAPHITES BY ATOMIC OXYGEN: KINETIC STUDIES. H. Marsh, T. E. O'Hair, and W. F. K. Wynne-Jones (Univ. of Newcastle-upton-Tyne, Eng.). Trans. Faraday Soc., 61: 274-84(Feb. 1965).

The oxidation of three amorphous carbons and an artificial graphite by atomic oxygen was studied in the temperature range from 14 to 350°C. The plasma of the radiofrequency discharge used to produce oxygen atoms was not in contact with the carbon sample. The rate of oxidation, at a fixed temperature, was dependent on the duration of the experiment. This rate was also temperature dependent and activation energies of 9.9 to 10.8 kcal $mole^{-1}$ are reported. The reaction was approximately first order with respect to atomic oxygen concentration. The rate of oxidation of the carbons, at constant temperature and concentration of atomic oxygen, was not influenced appreciably by the wide variations shown by the carbons in their chemical composition, internal surface area, pore sizes, and degree of crystallinity. At temperatures above 200°C, the measured

activation energy decreased and approached almost zero at 350°C. The factors, to which this is attributable, are discussed and evidence produced to show that surface oxide can retard the rate of oxidation. For one carbon, surface oxide was formed more readily from atomic oxygen than from molecular oxygen. The activation energy of gasification by atomic oxygen, and its relevance to the understanding of the mechanism of the reaction of molecular oxygen with carbon, is discussed. (auth)

18414 OXIDATION OF CARBONS AND GRAPHITES BY ATOMIC OXYGEN: AN ELECTRON MICROSCOPE STUDY OF SURFACE CHANGES. H. Marsh, T. E. O'Hair, and R. Reed (Univ. of Newcastle-upon-Tyne, Eng.). Trans. Faraday Soc., 61: 285-93(Feb. 1965).

Crystalline Ticonderoga graphite, a pyrolytic graphite, and two amorphous carbons were oxidized with atomic oxygen and those changes occurring on the surfaces were examined by optical and electron microscopy. Such a study assists in the understanding of the nature of "active sites" on carbonaceous surfaces. Unlike the reaction with molecular oxygen, atomic oxygen produced a general background of conical pits on surfaces of crystalline graphite, but not on the pyrolytic graphite, as well as what were considered to be etch pits, associated with defect structures. There was much less structural reaction anisotropy during oxidation by atomic oxygen than by molecular oxygen. The presence of iron on the surface of Ticonderoga graphite promoted recombination of atomic oxygen, thus decreasing oxidation rates and causing the formation of hexagonal hillocks. The edges of these hillocks were composed of $\{10\bar{1}0\}$ or zig-zag planes. There was evidence to suggest the presence of pure defect centers on Ticonderoga graphite. Amorphous carbons appeared to possess centers of preferential reactivity in that extensive pitting of the surface occurred. (auth)

18415 CORROSION BEHAVIOR OF CONVENTIONAL AND NEWLY DEVELOPED CAST HARD ALLOYS. A. Baeumel (Gebr. Bohler and Co., AG, Dusseldorf, Ger.). Werkstoffe Korrosion, 16: 11-20(Jan. 1965). (In German)

Conventional abrasion-resistant hard alloys on a cobalt-chromium-tungsten base are subject to considerable corrosion when exposed to strong acids. An examination of the influence exerted by the individual alloy constituents on the corrosion behavior of the hard alloys showed that the matrix is not resistant to the attack of acids with reducing effect while the carbide phase, which has a high tungsten content, is not resistant to the attack of acids with oxidizing effect. If, to the hard alloys, nickel (7%), molybdenum (3.5%), and copper (1.5%), which are almost exclusively concentrated in the matrix, are added, their corrosion resistance, especially to sulfuric acid, is greatly increased. Neither hardness nor abrasion resistance are affected. The great improvement in corrosion resistance is primarily due to the joint addition of molybdenum and copper. The addition of nickel causes only a small additional increase in corrosion resistance. But the nickel addition has the effect of improving the welding properties, which is of importance for the use of these hard alloys. If the tungsten is replaced by niobium, hard alloys, which also show a high corrosion resistance to oxidants, are obtained. While the hard alloys containing tungsten can be welded by means of oxyacetylene welding as well as argon arc welding, the hard alloys containing niobium can only be welded by the latter method. An examination of the abrasion strength properties showed that the hard alloys containing niobium are superior to those containing tungsten. (auth)

18416 THEORETICAL EQUILIBRIUM CORROSION OF REFRACTORY MATERIALS BY CONDENSED OXIDES. Robert W. Sprague. 19p. (CONF-641208-3)

From 3rd Conference on Performance of High Temperature Systems, Pasadena, Calif.

The equilibrium compositions of systems containing the condensed oxides aluminum oxide and beryllium oxide with several refractory materials were computed over the temperature range from 2000 to 5000°K, using a digital computer program based upon the minimization of system free energy. The results are presented in graphical and tabular form. (auth)

18417 THE OXIDATION AND HYDRIDING OF ZIRCONIUM ALLOYS IN TERPHENYL BASED NUCLEAR REACTOR COOLANTS. E. E. Charters and N. A. Graham (Canadian Westinghouse Co. Ltd., Hamilton, Ont.). 19p. (CONF-641915-1)

From 14th Chemical Engineering Conference, Hamilton, Ont., Can.

The application of zirconium alloys in organic-cooled nuclear reactors and the damaging consequences of surface oxidation and internal hydriding are discussed. An investigation was made of the factors affecting the uptake of hydrogen by zirconium alloys when they are exposed in autoclaves to terphenyls at elevated temperatures. System variables, which were evaluated, include temperature, dissolved hydrogen concentration, and dissolved water concentration. Many zirconium alloys were included and specific factors such as alloy composition, metallurgical condition, surface preparation, and oxidation kinetics during prolonged exposures were investigated. (auth)

18418 REDUCING CORROSION OF STAINLESS STEEL IN HOT NITRIC ACID SOLUTIONS BY ADDING CARBON BLACK OR ELEMENTAL SULFUR TO THE SOLUTION. F. G. Rust (to U. S. Atomic Energy Commission). U. S. Patent 3,174,818. Mar. 23, 1965.

A method was developed substantially reducing the corrosive effect toward stainless steel of a boiling nitric acid solution containing dissolved chromium ions in the +6 oxidation state. The corrosive effect of the Cr^{6+} was reduced by adding either carbon black or elemental sulfur to the boiling solution. The corrosion rate was markedly reduced by the addition of as little as 2 grams of carbon black or elemental sulfur per liter of boiling solution per day. (AEC)

Fabrication

18419 (AD-424207) DEVELOPMENT AND EVALUATION OF TUNGSTEN-BASE ALLOYS. Final Report, March 15, 1962–May 15, 1963. M. Semchyshen, Robert Q. Barr, and Gordon D. McArdle (Climax Molybdenum Co. of Michigan, Detroit). Nov. 15, 1963. Contract NOw-62-0419-c. 75p. $7.60(CFSTI).

Tungsten-base alloys were prepared by the vacuum-arc-casting process. Charges blended to obtain each of the aim compositions contained small additions of carbon to effect deoxidation during arc melting. One heat of the W–0.05% Zr composition was deoxidized with boron. Poor recoveries of wrought bar stock were experienced when conversion was attempted by conventional extrusion and rolling procedures. When the blanks were encapsulated in molybdenum, extruded, and swaged to ½-in.-diameter bar stock, good recoveries were obtained. Tensile and creep-rupture strengths of alloys were higher than those observed for unalloyed tungsten of comparable carbon content. The variation in strength and workability from alloy to alloy was noticeably sensitive to residual carbon and boron contents. Tensile transition temperatures were markedly influenced by the degree of deoxidation achieved during arc melting. (auth)

18420 (BMI-1694(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING SEPTEMBER 1964. Russell W. Dayton and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1964. Contract W-7405-eng-92. 37p. Dep.; $1.00(cy), 1(mn) CFSTI.

Progress is reported in research and development on reactor materials and components, reactor fuels, radioisotope and radiation applications, coated-particle fuel materials, fluoride-volatility process corrosive effects, and materials for ML-1 reactor. (J.R.D.)

18421 (BMI-1697(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING OCTOBER 1964. Russell W. Dayton and Ronald F. Dickerson (Battelle

Memorial Inst., Columbus, Ohio). Nov. 1, 1964. Contract W-7405-eng-92. 47p. Dep.; $1.25(cy), 2(mn) CFSTI.

Research and development are reported on reactor materials and components, ceramic reactor fuels, radiation-induced formation of organotin, coated-particle reactor fuels, fluoride-volatility process corrosive effects, and gas-cooled reactor fuels. (J.R.D.)

18422 (BMI-1715) JOINING OF ZIRCALOY AND INCONEL 600 TUBES BY EXPLOSIVE WELDING. Ronald J. Carlson and Charles C. Simons (Battelle Memorial Inst., Columbus, Ohio). Feb. 19, 1965. Contract W-7405-eng-92. 36p. Dep.; $1.00(cy), 1(mn) CFSTI.

Procedures were developed for producing 3.500-in.-OD by 3.300-in.-ID Zircaloy-to-Inconel tubular transition joints by explosive techniques. Initial experiments were conducted using a lap joint configuration to allow convenient variation of explosive welding parameters. It was determined that a minimum clearance of 0.040 in., a charge weighing considerably in excess of 60 g and located at a minimum stand-off distance, and either a grooved or a threaded joint interface were required to achieve welding. At the conclusion of these initial experiments the program was directed toward achieving welds with a tapered joint interface. The factors investigated included charge weight, surface roughness, evacuation of the joint interface prior to welding, included angle at the joint interface. It was found that surface roughness and included angle had little to no effect within the ranges investigated on the welding achieved. Contact charges of 10 to 12 g per $in.^2$, a scalloped joint interface formed by machining the mating surface of the Zircaloy tube, an initial clearance of 0.040 in., and a vacuum of ~20 μ of mercury were required to effect the desired welding. These explosively welded tubular transition joints possessed an average tensile strength of 97,500 psi at 10 per cent elongation over a 2-in. gage length and exhibited excellent behavior during thermal cycling from 150 to 750°F. (auth)

18423 (BRB-78) QUARTERLY PROGRESS SUMMARY [ON FUEL DEVELOPMENT], APRIL–JUNE 1963. (Bridgeport Brass Co., Seymour, Conn.). Dec. 13, 1963. Contract AT(30-1)-1405. 30p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A second test was conducted to determine the feasibility of electrochemically drilling long holes in solid U billets in preparation for extrusion. Electrode feed rates were established for a full-scale test. Two additional temperature sensitive instruments were evaluated for application to the extrusion process. One of these, a two-color pyrometer, offered advantages in eliminating the emissivity variation. The first in a series of experiments was conducted to evaluate the feasibility of piercing long, solid U billets. Preliminary results indicate very good adherence to dimensional tolerances. A series of experiments were concluded to determine a production process for the Dynapak forming a Mark V-B fuel elements. Difficulty was encountered in obtaining enough tubing for a double length element. The feasibility of extruding 13-in.-dia NPR-NOE primary ingots was explored. The increase in reduction ratio could be accomplished in production with few changes. Surface and dimensional analysis indicate no substantial difference compared with the 11-in.-dia ingots. A study of the production data to evaluate variables affecting the excessive oxidation problem indicated no discernible variable as the cause. Revised handling procedures have all but eliminated the present difficulties. (auth)

18424 (EUR-2214.f) FABRICATION DES ELEMENTS COMBUSTIBLES ECO EN CARBURE D'URANIUM. (Fabrication of ECO Uranium Carbide Fuel Elements). J. Briola and U. Heubner (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jan. 1965. 64p. Dep.(mn).

A description is given of the fabrication of the two first sets of aluminum-sheathed uranium carbide fuel elements for the ECO reactor (ORGEL critical experiment). The first set consists of 25 seven-rod clusters (pellet diameter = 25.2 mm; fuel length = 2,900 mm). The second set consists of 25 matrix-type four-rod clusters (pellet diameter = 30.9 mm; fuel length = 2,900 mm). (auth)

18425 (EURAEC-990) PREPARATION OF UO_2 POWDERS OF HIGH BULK DENSITY BY MELTING AND GRINDING AND THEIR PROCESSING TO FUEL ELEMENTS. Quarterly Report No. 14, October 1–December 31, 1963. (Nuklear-Chemie und -Metallurgie G.m.b.H., Wolfgang bei Hanau am Main (West Germany)). Work Performed under United States–Euratom Joint Research and Development Program. Contract 013-63-7/TEED. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The facility for melting UO_2 was equipped with a new more powerful transformer and altered in view of a considerably increased capacity. It is now possible to produce about 25 to 30 kg of molten UO_2 per day in four melting operations. The weight of the finished material of good quality obtained thereby is ab. 85 to 100% of the weight of the pellets used. Tests for melting in He and N_2 did not give any better results than those obtained under argon. Experiments have shown that a stoichiometric annealing within the temperature range of 800 to 1000°C yields satisfactory results. The gas content of the molten UO_2 is, after hot extraction attempts, 5 to 20 ppm of H_2 and 10 to 45 ppm of N_2; first measurements of the water content yielded approximately 1.5 ppm. Measured on amounts of 2 kg, the remainder which may be considered as waste after grinding in the jaw mill and screening of the UO_2 was 6 to 8%. The influence of various vibration processes on the average density and on the density distribution in steel tubes filled with UO_2 powder was examined. It was found that the same density values can be obtained by pneumatic and electro-dynamic vibration methods, but that there are characteristic differences in the density distribution. Measurements of peak-to-valley height showed that the average peak-to-valley height on the inside of the cans on account of the vibration process increases from about 1 to 2 μm to 2 to 4 μm. The data used were: width of gap 50 to 75 μm and stamper load 5 to 7.5 kp. A change of these parameters resulted in a considerable damage. Swaging tests on vibrated tubes evidenced a linear relation between elongation and vibration density with constant reduction of cross section. (auth)

18426 (EURAEC-1227) WELDING OF VERY THICK STEELS. Quarterly Report No. 12, July 1–September 30, 1964. (Rijksuniversiteit, Ghent (Belgium) and Soudometal, S. A., Brussels (Belgium)). Work Performed under United States–Euratom Joint Research and Development Program. Contract 042-61-9-RDB. 32p. Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

The majority of the work was devoted to the completion of global Robertson tests on transformation zones. Metallographic and fractographic examinations were carried out on the samples broken during the previous quarter and six new sets of results were also obtained to supplement the test series laid down in the program. No interpretation is possible until the entire series is available. Under the semi-global test program, the final complementary examinations were also carried out. These were aimed at determining the influence of the elastic energy stored in a testing machine on the Robertson arrest temperature of non-welded steel plating 30 mm thick and also at obtaining data concerning the paths followed by fractures in the joints with pre-existing defects subjected to semi-global tensile tests. In the former case, oscillographic readings showed that the fracture was complete well before energy, stored in the form of compressed springs, had time to act, while with regard to the determination of fracture trajectories, it was observed that the fractures were almost always situated in the bond zone or in the transformation zones. (auth)

18427 (EURAEC-1271) PLUTONIUM RECYCLING. Quarterly Report No. 16, July 1–September 30, 1964. (Commissariat à l'Énergie Atomique, [Fontenay-aux-Roses (France). Centre de Études Nucléaires]). Work Performed under United States–Euratom Joint Research and Development Program. Contract 037-60-12RDF. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Results of studies on dispersions of PuO_2 in inert oxides are reported. Fabrication of U–Pu pins and rough-cast

slugs is also reported. Analyses for Pu content during the fabrication process were performed by coulometry after resin separation. The rough-cast slugs were counted for spontaneous fission neutrons. Machining of slugs on a continuous-line canning process is reported, and fabrication of U–Pu alloys for oscillation tests is described. (J.R.D.)

18428 (GEAP-4777) AEC FUEL CYCLE PROGRAM. ASSEMBLIES 2L AND 3L. DESIGN AND FABRICATION OF FUEL RODS TO EVALUATE INCOLOY-800 CLADDING MATERIAL. J. P. Hoffmann, S. Y. Ogawa, and H. E. Williamson (Vallecitos Atomic Lab., General Electric Co., San Jose, Calif.). Dec. 28, 1964. Contract AT(04-3)-189. 38p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Incoloy-800 was used as a cladding material for fuel rods in two assemblies for irradiation testing in the Vallecitos Boiling Water Reactor. The alloy is a potential substitute for Type 304 stainless steel which was found to be susceptible to intergranular attack when used as a cladding for fuel rods operated in a boiling water reactor environment. The dimensions of the cladding were 1.067-cm OD by 0.051-cm wall and 1.079-cm OD by 0.0254-cm wall. Tubing in the annealed and cold-worked conditions was included. Sintered UO_2 pellets were used in the fuel rods. The fuel rods were designed so that the cladding would operate at various levels of applied stress. In one assembly, the design parameters minimize the operating stresses, while in the other, higher stress levels are promoted. (auth)

18429 (KAPL-3066) INVESTIGATION OF THE FORMATION OF LARGE ALPHA GRAINS IN SIMULATED WELD STRUCTURES OF ZIRCALOY-4. A. E. Bibb, A. P. Beard, and J. R. Fascia (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 28, 1964. Contract W-31-109-eng-52. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Formation of large alpha grains upon heat treatment (in the temperature range 1200–1500°F) of beta-quenched Zircaloy-4 (i.e., weld zones) was recognized as a potential performance limitation of welded Zircaloy components because of low ductility at room temperature resulting from hydride precipitates in the grains. Extensive investigations have been undertaken to provide a better understanding of this problem. The work has shown that (a) areas "cleared alpha prime" did not cause formation of large alpha grains; (b) large alpha grains did not grow across prior beta grain boundaries; (c) fine alpha prime structure in Zircaloy-4 (as the result of quenching) was more susceptible to formation of large alpha grains than a coarse alpha prime structure (from slow cooling); and, (d) increasing the iron content of Zircaloy-4 to 0.60 wt % eliminated formation of large alpha grains upon heat treatment. (auth)

18430 (LA-DC-6808) PLUTONIUM–CERIUM–COBALT FUEL DEVELOPMENT FOR MOLTEN REACTORS. D. R. Harbur, J. W. Romero, and J. W. Anderson (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Jan. 1965. Contract W-7405-eng-36. 26p. (CONF-650506-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

For Presentation at American Foundrymen's Society Meeting, Chicago.

The fuel which is under consideration for the molten plutonium reactor concept is a ternary plutonium–cerium–cobalt alloy in which the plutonium content can be varied considerably with only small variations in the melting point. Presently the fuel is prepared as vacuum cast rods, which are loaded into tantalum capsules. Obtaining fine-grained unsegregated castings on a production scale was one of the major problems encountered in the fuel development phase of this reactor program. This problem is discussed and the equipment and procedures developed for casting this fuel are described. (auth)

18431 (RTD-TR-8-112(V)) EXTRUDING AND DRAWING MOLYBDENUM TO COMPLEX THIN H-SECTION. Fifth Interim Technical Engineering Report, July 15, 1964–January 15, 1965. P. A. Santoli (Allegheny Ludlum Steel Corp., Brackenridge, Pa. Research Center). Contract AF33(657)-11203. 51p.

Thirteen H-shaped extrusions of wrought arc-cast TZM were made using maximum possible billet length of nine inches. A completed extrusion was possible to .058–.062-inch web thickness from 3360°F billet temperature. This extrusion was also accomplished from 3300°F with low carbon, wrought arc-cast TZM. As-extruded quality was good in surface finish and web dimensional run-out for twenty-foot lengths. However, considerable growth in fillet-radii occurred starting at a location of ten to twelve feet from the extrusion front-end. During extrusion, a failure in the tongue portion of a pressed and sintered solid zirconia nib resulted in considerable damage to support tooling. Extrusion trials with plasma-sprayed zirconia indicated promising results. (auth)

18432 (Y-1475) CHEMICAL COOLANTS FOR MACHINING URANIUM IN THE PRESENCE OF TRACE AMOUNTS OF CHLORIDE. T. P. Sprague, J. M. Googin, and L. R. Phillips (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Oct. 14, 1964. Contract W-7405-eng-26. 52p. Dep.; $3.00(cy), 2(mn) CFSTI.

The presence of trace amounts of chloride has been found to cause severe corrosion pitting of uranium during machining operations. A dibasic sodium phosphate solution will increase the chloride tolerance approximately ten times over a sodium nitrite–triethanolamine-type coolant. In the phosphate coolant, sodium caprylate is required to retard corrosion of cast iron in the machine tools and benzotriazole to eliminate corrosion of the copper alloys in the coolant circulation system and bearings. Results indicate that bacterial protection is also required for routine use. (auth)

18433 REACTIVE HOT-PRESSING: FABRICATION AND DENSIFICATION OF NON-STABILIZED ZrO_2. A. C. D. Chaklader and V. T. Baker (Univ. of British Columbia, Vancouver). Am. Ceram. Soc. Bull., 44: 258-9 (Mar. 1965).

The effects of applied pressure during polymorphic transformation of nonstabilized zirconia are discussed. Powdered zirconia was first compacted into a cylinder and then a pressure of 4000 psi was applied. The specimens were cycled through the temperature range of 800 to 1200°C very slowly so that during cycling under pressure the reversible phase transformation (monoclinic ⇌ tetragonal) occurred. Very dense and strong products were obtained. (M.C.G.)

18434 ANNEALING OF THE PRESSURE VESSEL OF TOKAI REACTOR. Atsushi Murakami and Tsuneo Nakanishi (Fuji Electric Mfg. Co., Ltd., Japan). FAPIG (Tokyo), No. 28, 196-200(Oct. 1963). (In Japanese)

The pressure vessel of the Tokai reactor is a large and complicated spherical vessel. The annealing of the vessel was successfully carried out in June 1963. The thermal conditions for the annealing were as follows: rates of heating and cooling, less than 10°C/hr; temperature held, 565°C ± 25°C; holding time, 12 hr; tolerable temperature differences, 100°C for below 300°C and 50°C for above 300°C. For heating the vessel, ribbon-type chrome wires were used within the vessel. Rock wool was used outside the vessel as the thermal insulating material. Three-hundred and seventeen C-A thermocouples were used for the temperature measurement at different places, and measured temperatures were used for the control of heating. After annealing the distortion of the vessel was 2 mm at the top and no defect was detected throughout the vessel. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

18435 TOSHIBA PROCESS FOR FABRICATING UO_2 PELLETS. Toraji Nishijima (Tokyo Shibaura Electric Co., Ltd.). Funtai Oyobi Funmatsuyakin, 11: 125-34(June 1964). (In Japanese)

In Toshiba, uranium oxide has been handled as reactor fuel since 1958. In the Toshiba process a rolling process is employed for physical treatment of the powder. By this treatment, coagulated porous particles are divided into

elementary fine particles and become suitable for pressing once organic additives are added. Organic additives in organic solution are applied. The additives are chosen on the basis of high lubricative ability among particles or between powder and die, easy dewaxing, and precise evaluation of the change of the weight between before and after dewaxing in the powder state. The feeding of powder from a hopper to a feeding shoe and from the shoe to the die holes was improved by automatic pressing. This method may control the precision of the green density within ±1.27% of the theoretical value even when a lot of pellets are treated. Unrecoverable loss is small even after the size of the pellet is ground so that the tolerance in diameter becomes ±0.02 mm. When the specification of the pellets was assumed to be $\phi = 9.90 \pm 0.02$ mm, $h = 15.00 \pm 0.15$, and $\rho = 94.5 \pm 1\%$ T.D., the yield was 91.10% and unrecoverable loss was 1.16%. When the specification was allowed to be $\phi = 10.00 \pm 0.15$, $h = 15.00 \pm 0.2$, and $\rho = 94.5 \pm 2\%$ T.D., the yield was raised to 97.15% and unrecoverable loss was decreased to 0.42%. (auth)

18436 THE HYDROSTATIC EXTRUSION OF DIFFICULT METALS. G. Ll. D. Pugh (National Engineering Lab., East Kilbride, Glasgow) and A. H. Low. J. Inst. Metals, 93: 201-17(Mar. 1965).

Hydrostatic extrusion forming processes are described and their advantages discussed. The apparatus used to investigate some aspects of the process is described, and consideration is given to the properties and behavior of high-pressure fluids and lubricants in this work. With difficult materials, an extension of the technique, fluid-to-fluid extrusion, was used; this enabled brittle materials to be worked cold. An account is given of the range of materials extruded by this method with a brief statement of the properties of the extruded products, where they were determined. (auth)

18437 THE REDUCTION OF YTTRIUM HALIDES BY THE MAGNESIUM METHOD OF OBTENTION OF MAGNESIUM–YTTRIUM ALLOYS. P. Caro (Centre National de la Recherche Scientifique, Bellevue, France). J. Less-Common Metals, 8: 235-55(Apr. 1965). (In French)

Rare earth metals are generally prepared by reduction of a halide with metallic calcium. But magnesium can be used for this purpose and an alloy can be obtained readily. For yttrium the equilibrium reaction magnesium-rare earth chloride dissolved in a fused salt bath was studied. There was excellent agreement between the experimental results and the results of calculations made from theoretical values of the different thermodynamic functions involved. The use of fluoride in place of the yttrium chloride, gave more concentrated alloys but the reaction was more complex, and difficult to understand theoretically. The alloys obtained contained up to 3.5% yttrium. Metallographic examination revealed a precipitate at the first lower concentrations. By distillation of the magnesium it was possible to obtain more concentrated alloys and to isolate intermediate compounds in the system. Three compounds were found: Mg_5Y, Mg_2Y, and MgY. Power diagrams were obtained for the last two compounds. The final stage of the distillation was yttrium metal itself, which could be obtained by this method at temperatures as low as 1000°C. (auth)

18438 PURIFICATION OF PLUTONIUM BY ZONE FUSION AND ELECTRODIFFUSION. B. Spriet (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Nucl. Mater., 15: 220-30(1965). (In French)

Results of the purification of plutonium by horizontal zone melting in a crucible, and by electrodiffusion, are presented. The effect of these treatments was followed by spectrographic analysis, chemical analysis, and metallography. In zone melting, most of the impurities in substantial concentration in plutonium are transported for zone velocities of about 8 mm/hr. In electrodiffusion, substitutional impurities (metals) move towards the anode, while interstitials (B, C) move towards the cathode. The phenomenon is the more pronounced, the higher the temperature, irrespective of the phase concerned. (auth)

18439 THE CERAMIC FOILS FOR REACTOR PHYSICS MEASUREMENT AT HIGH TEMPERATURE. Yukio Kohari and Eiji Fujimoto (Meidensha Electric Mfg. Co., Ltd., Japan). Meidensha Jiho, No. 51, 20-4(Oct. 1963). (In Japanese)

Very reliable sintered-ceramic foils are proposed for reactor physics measurements at high temperatures. The foils proposed are capable of being used in a wide range of temperatures up to about 1500°C. They essentially consist of alumina and rare earth oxide sintered together. Three kinds of ceramic foils have been developed: (1) alumina containing gadolinium oxide or samarium oxide for neutron-energy spectra measurement, (2) alumina containing dysprosium oxide for neutron-flux distribution measurement, and (3) alumina containing lutetium oxide for neutron kinetic temperature measurement. The procedure used for the preparation consists of mixing the rare earth oxide with α-alumina and an organic binder, compacting the mixture by a press, evaporating the organic binder by preheating, and sintering the green compact material in an electric furnace at about 1600°C in a stream of hydrogen gas containing a small amount of water vapor. The induced activities of these ceramic foils irradiated in JRR-1 were examined to determine the variation of the relative sensitivities. The values obtained were corrected for the detector used, the decay constant, the instrument characteristics, and the foil geometry. The standard deviations found were 6.3% for the dysprosium oxide–alumina ceramic foils (2.2 mmϕ × 0.5 mm thickness, 114 foils) and 2.0% for dysprosium oxide–alumina ceramic foils (12.0 mm × 0.4 mm thickness, 28 foils). (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

18440 ELECTROLYTIC PRODUCTION OF CHROMIUM–MOLYBDENUM ALLOY. Yu. D. Kudryavtsev, E. M. Golubchik, and V. A. Smirnov. Tr. Novocherk. Politekhn. Inst., 146: 41-6(1964).

For production of Cr–Mo alloys (containing 10-11% Mo) there is recommended the electrolytic composition (in g/l), CrO_3–250, MoO_4–80, H_2SO_4–2.5; at $D_k = 40$ a/dm^2 and a temperature of 45-50°C, the current efficiency is 11-12%. (OTS)

18441 INVESTIGATIONS OF SHIELDING MATERIALS. [PART] I. STUDIES OF BORON–GLYCERIN LITHARGE CEMENT. Toshio Sugiura, Keiichi Murakami, and Hirobumi Tanaka (Tohoku Univ., Sendai). Yogyo Kyokai Shi, 17: 135-40(1963). (In Japanese)

Studies were made of a type radiation shielding material, which can be molded easily, has excellent physical strength, and the ability to shield against gamma radiation and neutrons. Boric acid can be dissolved in glycerin forming a complex (borospiranic acid). The materials are prepared by tempering litharge with the complex solution containing glycerin and boric acid. Because of the high absorption cross section of boron for thermal neutrons and the high absorption coefficient of lead for gamma radiation, the prepared materials are effective for radiation shielding. The effects of various factors involving the ratio of glycerin to boric acid, the ratio of litharge to glycerin solution, and curing time on strength and hardness were investigated. The maximum bending strength was 141 kg/cm^2, and the compressive strength was 403 kg/cm^2. Other advantages are adequate setting time and large bending strength. The calculated half thickness was 2 cm for 1-Mev gamma radiation and 0.35 cm for thermal (2200 m/sec) neutrons. Studies of the mechanism of setting and identification of formed compounds are under way. (auth)

18442 INDUCTION SINTERING FURNACE, 8N (Engineering Materials). (Union Carbide Corp. Nuclear Div. Y-12 Plant, Oak Ridge, Tenn.). (CAPE-864). (1 DRAWING).

A design is presented for one of nine induction furnaces used in sintering powdered metal configurations, including uranium. A graphite mold is used for casting the powdered metal. The mold is held together by a binder, which burns out during firing. The hot zone is 34 in. dia, 35 in.

long, and is used with a hydrogen or nitrogen atmosphere. For details see TID-4100. (M.C.G.)

18443 FUEL ELEMENT FOR NUCLEAR REACTORS AND PROCESS FOR ITS MANUFACTURE. Walter Blomeyer and Gunther Schneider (to Nukem Nuklear-Chemie and Metallurgie GmbH). Canadian Patent 700,831. Dec. 29, 1964. Priority date Nov. 4, 1960, Germany.

To prevent the undesirable diffusion of aluminum sheathing in a uranium fuel element, the fuel is coated with a nickel layer about 5 to 7 μm thick. The inside of the aluminum sheath is coated with a 4 to 6 μm layer of nickel. Before the sheath is applied to the coated fuel element a 3 to 5 μm layer of chromium is added on top of the nickel layer. Bonding of fuel element and sheath with interposed layer of chromium is done at 600°C and a pressure of 80 atm. Neutron losses to the aluminum are reduced by this means of fabrication. (F.S.A.)

18444 METHOD OF MAKING PLUTONIUM OXIDE SPHERES. L. V. Jones, D. Ofte, P. A. Tucker, and L. J. Wittenberg (to U. S. Atomic Energy Commission). U. S. Patent 3,171,714. Mar. 2, 1965.

A method was developed for making ceramic plutonium oxide microspheres, which are chemically and thermally stable and free of contamination or radiation hazards normally associated with plutonium. These microspheres may be formed by injecting plutonium oxide particles into a radiofrequency-coupled plasma torch where the temperatures are about 14,000 to 19,000°K so as to rapidly heat the plutonium particles above their melting point to provide spherical configuration. (AEC)

18445 METHOD FOR PREPARATION OF SPHERICAL THORIUM DICARBIDE AND THORIUM–URANIUM DICARBIDE PARTICLES. A. T. Kleinsteuber (to U. S. Atomic Energy Commission). U. S. Patent 3,171,715. Mar. 2, 1965.

A process was developed for preparing thorium dicarbide and thorium-uranium dicarbide in the form of spherical particles for use in nuclear reactor fuel elements. An aqueous thorium oxide sol containing nitrate ion at a nitrate-to-thorium molar ratio of 0.05 to 0.15 is mixed with finely divided carbon at a carbon-to-thorium molar ratio of at least 4 to 1. The mixture is dispersed in a water-immiscible, inert organic liquid under agitation at a predetermined rate to produce sol droplets of a controlled size. The droplets are then solidified by addition of a low-molecular-weight alcohol or acetone. The resulting gel particles are recovered and fired at a temperature of at least 1400°C in an inert atmosphere for conversion to carbide. Up to 10 mole % uranium values may be incorporated in the thorium oxide sol to produce thorium-uranium dicarbide particles. (AEC)

18446 METHOD FOR PREPARATION OF THORIUM DICARBIDE AND THORIUM–URANIUM DICARBIDE PARTICLES. J. L. Kelly, O. C. Dean, and D. E. Ferguson (to U. S. Atomic Energy Commission). U. S. Patent 3,171,815. Mar. 2, 1965.

A process was developed for preparing spherical thorium dicarbide and thorium-uranium dicarbide particles for nuclear reactor fuel elements. A thorium oxide sol containing nitrate ion at a nitrate-to-thorium molar ratio of 0.05 to 0.15 is mixed with finely divided carbon-to-thorium molar ratio of at least 4 to 1. The mixture is dispersed in droplet form and the droplets are dried to produce spherical solid gel particles. The particles are converted to carbide by firing at a temperature of at least 1400°C in an inert atmosphere. Thorium-uranium dicarbide particles are obtained by providing uranium values in the sol at a proportion up to 10 mole % of the total metal values. The thoria sol-carbon mixture can also be evaporated to produce a dried gel cake and the gel cake converted to spherical particles by comminution. (AEC)

Properties and Structure

Refer also to abstracts 18107 and 18133.

18447 (AD-423981) MOLYBDENUM SHEET ROLLING PROGRAM. Interim Report No. 22, July 26–October 25, 1963. R. G. McLaughlin and W. J. Schoenfeld (Universal-Cyclops Steel Corp., Bridgeville, Pa. Refractomet Div.). Nov. 18, 1963. Contract NOas-59-6142-c. 61p. $5.60 (CFSTI).

Release properties for Mo–5Ti and TZM alloy sheet, developed and submitted to the Bureau of Weapons for approval, are presented. When approved, these release properties will be the criteria for final inspection and acceptance of production lots of Phase III sheet. Test results of 0.020 in. Mo–5Ti sheet are included which show some scatter outside the limits of the release properties. This completes work on this alloy. Details of the melting and extrusion of the additional TZM ingot are discussed. Test certificates containing evaluation data from specimens representing approximately one-third of the total TZM sheets rolled in Phase III are included. These properties meet the requirements of the release properties and reflect the consistent quality of various gages of TZM produced. (auth)

18448 (AECL-2169) OBSERVATIONS ON THE THERMAL CONDUCTIVITIES OF CERTAIN PARTIALLY-REDUCED CERAMIC OXIDES. J. R. May and R. L. Stoute (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1965. 49p. Dep.; $1.50(AECL).

The thermal conductivities of small ceramic specimens were compared in pairs using a very simple apparatus that yields only qualitative results. The comparisons apply for mean temperatures up to 1200°C. Earlier results, showing that partial reduction can enhance the thermal conductivity of UO_2, were confirmed. Possible differences of emissivity between paired specimens were eliminated by depositing surface coatings on both. The continued difference of specimen temperatures under these conditions demonstrated that differences in specimen conductivity were indeed responsible. Contrary to earlier observations in this apparatus, the conductivity of a single crystal was greater than that of a polycrystalline sinter (both stoichiometric), but the improvement was less than that achieved by reducing the sinter to $UO_{1.98}$. A similar dependence of the thermal conductivity on composition was found for ThO_2, $(Th, U)O_2$, and ZrO_2. Observations on MgO, Al_2O_3 and TiO_2 were inconclusive. Additions of the order of 0.1 mole % Y_2O_3, La_2O_3, TiO_2, ZrO_2, or Nb_2O_5 were made to UO_2 and the effect of partial reduction on the conductivity studied. All gave results generally similar to pure UO_2, but with the first two additives the increased thermal conductivity occurred at lower temperatures. An addition of Y_2O_3 to ThO_2 had a similar beneficial effect. (auth)

18449 (AERE-R-4742) INITIAL INVESTIGATION OF THE THORIUM–PLUTONIUM–CARBON SYSTEM. J. T. Dalton and R. M. Griffin (Atomic Energy Research Establishment, Harwell (England)). Sept. 1964. 20p. Dep.(mn).

An investigation by x-ray diffraction and ceramographic techniques of arc melted and heat treated samples of alloys in the Th–Pu–C system has shown that at least 40 mol % PuC_2 is soluble in ThC_2 and that the resultant $(ThPu)C_2$ alloys are monoclinic in structure at low temperatures. The theoretical densities of these alloys range from 9.2 g/cm³ for ThC_2 to 9.68 g/cm² for $(Th_{0.6}\ Pu_{0.4})C_2$. The temperature of the phase transformations in hyper- and hypostoichiometric ThC_2 has been determined by dilatometry. Hyperstoichiometric alloys show two phase transformations, one at 1350°C (±15°C) and the other at 1475°C (±10°C); there is also some evidence of a third transformation at ~1400°C. Hypostoichiometric ThC_2 shows four changes in apparent expansion rate at 1252°C (±10°C), 1325°C (±10°C), 1404°C (±15°C), and 1478°C (±15°C), and these have been interpreted in the light of present understanding of the Th–C system. Alloys containing 5.1 to 8.3 wt % C with less than 30 wt % Pu consisted of monocarbide and dicarbide phases only, regardless of their previous heat treatment history. No evidence for the existence of Th_2C_3 or $(ThPu)_2C_3$ has been found. (auth)

18450 (COO-578-P27-4) YIELD PHENOMENA AND FRACTURE OF HYDRIDED ZIRCONIUM. Quarterly Report, October 1–December 31, 1964. D. Weinstein (IIT Research Inst., Chicago, Ill.). Feb. 1, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-578. 32p. (EURAEC-1336). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The observations of yield point phenomena in single-crystal and polycrystalline zirconium over the past ten years are recounted, and the mechanisms proposed for yield occurrence are presented. While the Cottrell mechanism and other locking/subsequent unlocking mechanisms have been advanced for explanation of yield point occurrence, the characteristics of this phenomenon in zirconium do not appear to conform to the classical concepts of the Cottrell theory. Moreover, little experimental effort has been devoted to study of discontinuous yield in zirconium. The concepts involved in explanation of yield point appearance by interaction of dislocation networks and by rapid multiplication of dislocations are presented. Although yield point appearance in polycrystalline zirconium by the former mechanism is not discounted, discussion is given indicating that the dislocation multiplication process might be significant in explaining yield points in zirconium. The initial scope of experiments designed to bring the yield behavior of zirconium within the framework of this theory is presented, and some results of preliminary work are given. (auth)

18451 (DP-328) GRAIN REFINEMENT OF URANIUM BY A BETA-QUENCH, ALPHA-ANNEAL PROCESS. Carl L. Angerman, Richard T. Huntoon, and William R. McDonell (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.). Feb. 1959. Contract AT(07-2)-1. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A grain size of approximately 0.10 mm may be produced in beta-transformed uranium by quenching from a temperature in the beta phase and subsequently annealing in the alpha phase at a temperature above 600°C. This result is in contrast to the grain sizes of 0.35 mm and greater produced in metal that is air cooled after beta transformation. A significant portion of the grain refinement is produced by recrystallization of the beta-quenched structure during the high-alpha anneal. Preliminary in-pile tests indicate that uranium plate that is heat treated by the "quench-and-anneal" process undergoes no surface roughening, in contrast to air-cooled plate, and is dimensionally stable. Similarly, heat-treated rods also show improved surfaces, but are dimensionally less stable than the plate. (auth)

18452 (EURAEC-996) METALLOGRAPHY OF URANIUM NITRIDE. W. Musser, A. A. Bauer (Battelle Memorial Inst., Columbus, Ohio); and J. Bugl (European Atomic Energy Community). 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 8p. (CONF-105-2; EUR-2228.e). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 17th Atomic Energy Commission Metallography Group Meeting, Los Alamos, N. Mex., May 1963.

Techniques were developed for the preparation of metallographic samples of uranium nitride. Various etching techniques were found to be required for optimum phase delineation and identification, depending upon the phases present and type of microstructural detail desired. (auth)

18453 (EURAEC-1254) PHYSICAL PROPERTIES OF UO_2 SINGLE CRYSTALS. Quarterly No. 10, March 1–June 30, 1964. (Centre d'Étude de l'Énergie Nucléaire, Mol (Belgium)). Work Performed under United States–Euratom Joint Research and Development Program. Contract 056-64-3-TEEB(RD). 30p. (R-2320) Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Controlled Oxidation of UO_2 to UO_{2+x}. The experimental procedure has been slightly modified by introducing an inert gas (Ar or He) in the furnace up to a pressure of a few hundred torr. The morphology of the U_4O_9 precipitates in UO_{2+x} for various oxygen excess has been studied in detail. Kuczynski-type Sintering Experiments. Only few reliable results were obtained hitherto. The first sintering experiments seem to point to neck growth proportional to the square root of time. This would be due to viscous or plastic flow. U Self-diffusion in UO_2. The amount of ^{235}U diffused in the UO_2 lattice will be determined by a gamma spectrometric analysis of the Ba–^{140}La peak after reactor irradiation. The first results obtained with this method were checked by mass spectrometry. Thermal Conductivity. The thermal conductivity of a carefully reduced UO_2 single crystal has been measured between 4 and 300°K. The maximum in thermal conductivity, observed at 12°K for a slightly oxidized crystal; (O/U 2.005) is shifted towards lower temperatures for the stoichiometric sample; its value is then about ten times higher than for the oxidized crystal. Hall Effect Measurements. Hall effect measurements have been performed on highly oxidized UO_2 single crystals (UO_{2+x} with large x and U_4O_{9-y}). The Hall mobility at room temperature for a p-type sample was $(1.2 \pm 0.2) \times 10^{-2} cm^2V^{-1}sec^{-1}$, whereas for two n-type samples a value of $1.5 \times 10^{-2} cm^2V^{-1}sec^{-1}$ has been found. Effect of Fast Electron Irradiation on Electrical Conductivity. Fast electron (3.5 Mev) irradiation caused an increase in the electrical conductivity of an as-grown UO_2 crystal. Recovery experiments showed the presence of an annealing peak around 135°C. The energy of defect migration calculated according to Balarin and Zetzsche's method, is equal to 1.0 ev. The most evident explanation for the recovery stage at 135°C, is oxygen interstitial migration. Thermoelectric power measurements. A new measuring technique, enabling measurements to be made while the absolute temperature is changing, has been adopted. The thermoelectric power of four crystals (composition O/U = 2.12 and O/U = 2.11) has been measured at temperatures ranging from about 330 to 130°K. (auth)

18454 (EURAEC-1276) A STUDY ON PLASTIC FATIGUE EMBRITTLEMENT IN REACTOR VESSEL STEELS. Quarterly Report No. 4, October 1–December 31, 1964. (Centre National de Recherches Metallurgiques, Liege (Belgium)). Jan. 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 005-63-12 TEEB. 40p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

The major part of the tests which have been carried out were devoted to an extension of the knowledge obtained so far on the phenomenon of plastic fatigue damage in alternate biaxial bending. Endurance curves were plotted for two of the steels at ambient temperature, and for three steels at 300°C. Fatigue tests at 300°C showed a significant influence of the maintenance periods with imposed maximum deformations: these seem to lead to some endurances from 30 to 40% below those obtained under simusoidal stress. The effect of the ageing period at 300°C was also partially studied during the test. Impact tests carried out on flat test pieces damaged by alternate bending plastic fatigue at 300°C showed that the embrittlement resulting from inflicted damage was not considerably greater than that observed after fatigue at ambient temperature. This temporary conclusion, however, only applies within the limits of the studied damage and of the methods adopted for brittleness measurements. (auth)

18455 (HW-80808) PHYSICAL DAMAGE IN PLUTONIUM. R. D. Nelson, T. K. Bierlein, and F. E. Bowman (Hanford Atomic Products Operation, Richland, Wash.). Feb. 1964. Contract AT(45-1)-1350. 27p. Dep.; $2.00 (cy), 1(mn) CFSTI.

High quality as-cast plutonium may contain a large volume of microcracks that have formed during the $\beta \rightarrow \alpha$ transformation. The volume of microcracks increases with increasing transformation temperature, higher metal purity, increased specimen size, and after $\alpha \rightleftharpoons \beta$ thermal cycling. Thermal cycling produces growth in all directions, general distortion, and extensive surface rumpling. Plutonium containing no microcracks can be produced by quenching from the beta phase to –75°C during casting. No physical damage has been observed in metal that ini-

tially contains no microcracks after either $\gamma \rightleftharpoons \beta$, $\delta \rightleftharpoons \gamma$, or $\delta \rightleftharpoons \beta$ thermal cycling. (auth)

18456 (MSAR-65-28) EFFECT OF HIGH-TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report No. 53, January 1965. (MSA Research Corp., Callery, Pa.). Feb. 24, 1965. Contract AT(11-1)-765. 42p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

The status of work in the research program is summarized. The progress of Test 3 (Type 316 stainless steel in 1200°F high-carbon sodium) is reported; the results to date indicate that carbon contamination in sodium reduces the fatigue life, impact strength, and ductility while increasing the creep-rupture life. Similarly, an increase in creep-rupture strength and a decrease in ductility and minimum creep rate were observed in Test 5 (Type 316 stainless steel in 1200°F high-oxygen sodium). Metallographic analysis and chemical analysis of sodium are reported. Special fatigue runs on Type 304 stainless steel indicate a shorter fatigue life in 1200°F high-oxygen sodium than in 1200°F air. (D.L.C.)

18457 (MSAR-65-38) EFFECT OF HIGH-TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report No. 54. (MSA Research Corp., Callery, Pa.). Mar. 16, 1965. Contract AT(11-1)-765. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A summary is presented of the status of work on the effects of high-temperature sodium and contaminants on the mechanical properties of Type 316 stainless steel and 2¼ Cr–1 Mo steel. Results to date for Tests 3 and 5 (Type 316 stainless steel in high-carbon and high-oxygen sodium at 1200°F) indicate that the contaminants increase the creep-to-rupture life and reduce the ductility. Results of sodium sample analyses for impurities are tabulated. The development of extensometers for measuring creep rates in sodium is discussed briefly. (D.L.C.)

18458 (NASA-CR-54286) DETERMINATION OF ELEVATED-TEMPERATURE FATIGUE DATA ON REFRACTORY ALLOYS IN ULTRA-HIGH VACUUM. Quarterly Report No. 2, October 1, 1964–January 1965. C. R. Honeycutt and J. C. Sawyer (TRW Equipment Labs., Thompson Ramo Wooldridge Inc., Cleveland, Ohio). Feb. 12, 1965. Contract NAS-3-6010. 22p. (N65-17455). $1.00 (CFSTI).

The final design of the vacuum fatigue test chambers has been reviewed and approved for manufacture. Work is continuing with a bench setup to study the problems associated with the development of a suitable loading system. The current design, which employs a piezoelectric transducer, a 200-watt amplifier, and stepped horns operating at resonance (approximately 20 Kcs), is capable of consistently producing fatigue failure in ¼-inch diameter brass specimens at room temperature. (auth)

18459 (NASA-CR-54287) GENERATION OF LONG-TIME CREEP DATA OF REFRACTORY ALLOYS AT ELEVATED TEMPERATURES. Quarterly Report No. 6, September 26–December 26, 1964. J. C. Sawyer and C. H. Philleo (TRW Equipment Labs., Thompson Ramo Wooldridge Inc., Cleveland, Ohio). Jan. 15, 1965. Contract NAS-3-2545. 48p. (N65-16747). $2.00(CFSTI).

Creep data are presented for tungsten, tungsten–25% rhenium, TZM molybdenum alloy, and AS-30 columbium alloy with photomicrographs of the microstructure before and after test. On the basis of the current test results, the creep strength of tungsten is less than that of tungsten–25% rhenium sheet alloy at 3200°F. In the case of turbine alloys at 2000°F, preliminary tests show that the TZM alloy in the forged condition has a greater creep strength than cross-rolled AS-30 plate material. (auth)

18460 (NMI-1265) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. FUNDAMENTALS OF SINGLE-CRYSTAL DEFORMATION IN ZONE-REFINED BERYLLIUM. Final Report, July 1, 1963 through June 30, 1964. D. F. Kaufman and L. R. Aronin (Nuclear Metals, West Concord, Mass.). Mar. 1, 1965. Contract AT(30-1)-2784. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The highest purity level to date was sought by subjecting double distilled beryllium to six zone-refining passes. A preliminary assessment of the purity level of the resulting crystal was made by resistance ratio measurements. The value observed, $R_{298}/R_{4.2} = 3300$, indicates that an appreciably higher purity level has been achieved. The search for possible new modes of deformation in higher purity material was continued by means of "c" axis compression tests. This study was extended from the purity level of 6 pass SR ($R_{298}/R_{4.2} = 250$) to that of 12 pass distilled ($R_{298}/R_{4.2} = 1100$). As was observed in tests at lower purity levels, the 12 pass material sustained elastic loading in "c" axis compression into the 200–300,000 psi range at 225°C. No slip with a direction out of the basal plane was observed. "C" axis contraction to relieve plastic anisotropy thus does not appear possible in the purity range $R_{298}/R_{4.2} = 2.5$ (commercial) to 1100 (12 pass distilled). Realloying studies concerned both solid solution additives such as iron and nickel and the combination additions (Fe + Si) and (Fe + Si + Al) which are believed to impair ductility by precipitate formation. The solid solution additions iron and nickel were shown to be beneficial to deformation behavior by reducing the high anisotropy ratio (CRSS $(10\bar{1}0)$/CRSS (0001)) resulting from zone-refining. The high basal glide capacity resulting from purification is retained with these additions. The studies involving the combination additions (Fe + Si) and (Fe + Si + Al) were inconclusive due to poor recovery of the silicon and aluminum additives. (auth)

18461 (NRL-6221) DIFFUSION IN COLUMBIUM RICH COLUMBIUM–TITANIUM ALLOYS WITH CONSIDERATION OF THE POSSIBILITY THAT THE DIFFUSION COEFFICIENT IS TIME DEPENDENT. T. C. Reuther, Jr. (Naval Research Lab., Washington, D. C.). Dec. 14, 1964. 165p. $3.00(CFSTI).

Thesis submitted to Catholic Univ. of America, Washington, D. C.

Interdiffusion has been studied in Nb vs Nb–8.5 at. % Ti and Nb vs Nb–35 at. % Ti couples at temperatures of 1300 to 2000°C and for times of 0.1 to 1000 hours. The electron microprobe has been used to obtain the penetration curves. Marker displacement toward and the development of porosity within the alloy at 1800 and 2000°C demonstrate that a vacancy mechanism is operative in this bcc alloy system. Porosity was also observed at 1500°C. At 1500°C for anneal times extending from 10 to 1000 hours for the more dilute alloy and from 10 to 120 hours for the 35 at. % Ti alloy, the interdiffusion coefficient D computed by the Boltzmann-Matano analysis is determined to be independent of time. The Arrhenius plot for results extrapolated to 100 at.% Nb is a straight line and yields an activation energy of 110 k cal/g-atom. However, as composition is increased to 30 at. % Ti, an increase in the concentration dependence of D is observed with decreasing temperature. This is manifest by curvature of the log D vs. 1/T plots with increasing titanium content.

18462 (ORNL-TM-1063) MAGNETIC STRUCTURE PROPERTIES OF SOME HEAVY RARE EARTH ALLOYS. Harry Ray Child (Oak Ridge National Lab., Tenn.). Feb. 23, 1965. Contract [W-7405-eng-26]. 106p. Dep. (mn); $4.00(cy), 2(mn) CFSTI.

Thesis submitted to Univ. of Tennessee, Knoxville.

A neutron diffraction study was made of the magnetic structures of the following alloys: Tb–Y, Dy–Y, Ho–Y, Er–Y, Tm–Y, Tb–Lu, Tb–Dy, Tb–Ho, Tb–Er, Tb–Tm, Dy–Ho, and Ho–Er. The magnetic properties of the pure metals Gd to Tm are also described. A summary is presented of the theory of rare earth magnesium, and the results are discussed in terms of the theory. (D.L.C.)

18463 (PAN-570/II) LATTICE DYNAMICS OF HEXAGONAL CLOSE-PACKED STRUCTURE. Andrzej Czachor (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Nov. 1964. 35p. (CONF-804-26)

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

Lattice dynamics of the hexagonal close-packed structure in the Born-von Karman approximation, assuming interactions with any number of neighbors, were studied. General properties of the dynamical matrix, reflecting symmetry properties of the hcp structure, have been established. Using operations of a symmetry group, the families of equivalent lattice points and their force matrices have been evaluated. This has allowed one to obtain the elements of a Fourier transform of the dynamical matrix. By the use of the long waves procedure, the general formulas of elastic constants expressed through elements of the dynamical matrix have been obtained. Finally, the factorisation of the secular equation of the problem have lead to the phonon dispersion relations for symmetry directions. In the course of the work, a nomenclature convenient for further analysis has been developed. (auth)

18464 (PAN-599/VI) NEUTRON-DIFFRACTION STUDY OF THE MnHg ALLOY. Andrzej Oleś (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Nov. 1964. 18p.

Neutron diffraction patterns have been obtained at 4.2 and 300°K for MnHg. The antiferromagnetic arrangement of the magnetic moments exists even at room temperature. The Néel point has been established at 460°K by both the neutron method and the measurement of the magnetic susceptibility. The magnetic moment of the manganese atom was found to be $(3.7 \pm 0.2)\ \mu_B$. It was found by means of the neutron method that there is a change of the direction of easy magnetization at 198°K. (auth)

18465 (PWA-2518) DETERMINATION OF THE EMISSIVITY OF MATERIALS. Semi-Annual Progress Report, May 14–November 15, 1964. R. C. Emanuelson (Pratt and Whitney Aircraft, East Hartford, Conn.). Contract NAS3-4174. 52p.

The effect of a simulated space environment on selected high-emittance coatings is being evaluated. The coatings were applied to either AISI-310 stainless steel or columbium–1 percent zirconium alloy. The results obtained to date indicate that calcium titanate and iron titanate are suitable materials for space radiator coatings. Four total hemispherical emittance rigs used in a previous program were modified to permit specimens to be tested at temperatures up to 1800°F at pressures lower than 10^{-7} mm Hg for periods up to 5000 hours. The selection of materials for long-term emittance testing was based on results from previous emittance programs and on the results of a study of the literature. Candidate materials were subjected to short-term emittance testing to confirm that their emittance was 0.85 or better and that their stability during exposure to high temperature and vacuum warranted extended testing. During the report period, coatings of calcium titanate, iron titanate, and a zirconium diboride–molybdenum disilicide composition were subjected to short-term emittance testing. The results indicated that calcium titanate and iron titanate were suitable for long term emittance testing. Three specimens are being tested in the long-term total hemispherical emittance rigs. The first of these is AISI-310 stainless steel coated with calcium titanate. This test is being conducted at 1350°F and about 2000 hours have been accumulated to date. The emittance has been stable at 0.91 throughout the period. The second specimen is AISI-310 stainless steel coated with iron titanate. A total of about 1000 hours with a steady emittance of 0.89 have been accumulated. The third specimen is columbium–1 percent zirconium coated with iron titanate. The emittance for this specimen varied between 0.88 and 0.85 during the 1950 hours of testing at 1700°F accumulated to date. These tests will be continued until each specimen has been tested for 5000 hours. Adherence tests were conducted on AISI-310 stainless steel specimens coated with 4-mil layers of calcium titanate. The adherence was evaluated by vibrating the specimen at a frequency of 120 cps for up to 10^7 cycles with a maximum stress of 55,000 psi. There was no indication of coating separation or spalling during the test. The tests were terminated by failure of the substrate. (auth)

18466 (UCRL-7539(Rev.I)) THE CRYSTAL STRUCTURE OF HIGH BERYLLIA. Deane K. Smith, Carl F. Cline (Lawrence Radiation Lab., Univ. of California, Livermore); and Stanley B. Austerman (Atomics International, Canoga Park, Calif.). Jan. 14, 1964. Contracts W-7405-eng-48 and AT-11-1-GEN-8. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The crystal structure of high-temperature beryllia was determined using X-ray powder data collected at 2100°C. The structure is tetragonal with $a = 4.75$ Å and $c = 2.74$ Å, and contains four molecules of BeO in the unit cell. The density is 2.69 g/cc. The structure is related to rutile, TiO_2, in that the oxygen arrangement is identical. Beryllium atoms are in tetrahedral sites. The space group is $P4_2/mnm$, and the oxygen and beryllium atoms are in sites 4f and 4g, respectively with $x_O = 0.310$ and $x_{Be} = 0.336$. (auth)

18467 (UCRL-7938) OXYGEN-18 DIFFUSION IN SURFACE DEFECTS ON MgO AS REVEALED BY PROTON ACTIVATION. J. Birch Holt and Ralph H. Condit (Lawrence Radiation Lab., Univ. of California, Livermore). Feb. 1, 1965. Contrac W-7405-eng-48. 22p. (CONF-641116-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Conference on the Role of Grain Boundaries and Surfaces in Ceramics, Raleigh, N. C.

A study of the effect of surface defects on the self-diffusion of oxygen in MgO is reported. The technique involves exchange with oxygen-18 enriched gas followed by proton bombardment to yield the radioisotope, fluorine-18. This may be treated as a normal radioactive tracer. The penetration distribution of the oxygen isotope is indicated by autoradiography. Preferential diffusion of oxygen down bicrystal grain boundaries is definitely proven. Dislocations introduced by cold working are found to contribute to the overall rate of oxygen diffusion. Surface fractures are shown to be important channels for the rapid movement of oxygen. The implications of these findings are discussed. (auth)

18468 (UCRL-11861) STRUCTURES AND STRENGTH OF AUSFORMED STEELS (thesis). Om Johari (Lawrence Radiation Lab., Univ. of California, Berkeley and California Univ., Berkeley. Dept. of Mineral Technology). Jan. 1965. Contract W-7405-eng-48. 117p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Substructures of conventional and ausformed steels were examined using transmission electron microscopy to determine the causes of strengthening of these steels and to better understand the role of the parameters of ausforming. Steels based on Fe–25% Ni–0.3%C, with carbide forming alloying elements (Cr, V, and Mo) were examined in both austenitic and martensitic conditions. Undeformed steels were studied and compared with steels ausformed 8 and 30% at 100°C and 500°C. Dark field analyses were done in most cases to study substructural features such as precipitates and twinning. Precipitates and a high density of dislocations were observed in austenites and martensites of all 30% ausformed steels. A critical amount of ausforming was necessary to nucleate the precipitates and this amount was between 8 and 30% in all the steels examined. The precipitates are identified as Fe_3C, VC, MoC and probably $Cr_{23}C_6$. For the steels containing carbide formers, neither the precipitates could be grown nor the dislocation density reduced by low temperature tempering in the microscope. Similar treatments produced extensive growth of cementite in Fe–Ni–C steel. Two temperatures of deformation and different compositions of the steels showed little substructural differences. The higher strength resulting from ausforming is primarily due to the increased dislocation density. The precipitates play an important role by providing sites for dislocation multiplication and pinning. The role of carbon and strengthening was mainly through providing precipitates. No systematic variation of martensite plate sizes with ausforming parameters could

be detected. The extent of twinning in martensites decreased with increasing amount of ausforming. This suggested that the occurrence of transformation twinning was favored by a low Ms temperature. Twinning in some austenites was observed. This may be due to the effects of solutes in lowering the stacking fault energy. The absence of twinning and high density of dislocations probably accounts for the better ductility of ausformed steels. It is proposed that explosive deformation of ausformed steels, alloying and ausforming to give deformable precipitates, and explosive deformation of dispersion hardened materials containing suitable precipitates be investigated further to obtain materials with higher strength and better ductility. (auth)

18469 (UCRL-11897) CLIMB OF IMPERFECT DISLOCATIONS IN ALUMINUM (thesis). Nathapet Durai Raghaven (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 1965. Contract W-7405-eng-48. 34p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Climb of imperfect dislocations in aluminum of 99.999% purity was by transmission electron microscopy. Annealing at different temperatures of the electron microscope specimens was carried out in a furnace, the specimen being periodically returned to the electron microscope for observation of selected dislocation loops. Friedel's theory of dislocation climb has been applied to the climb of imperfect loops to explain the observed rates of decrease in loop diameter with annealing time at various temperatures. The experiments give 130 ergs/cm^2 as the stacking fault energy of aluminum. (auth)

18470 (FTD-TT-64-371) JOURNAL OF PHYSICS (SELECTED ARTICLES). Translated from Wu Li Hseuh Pao, 19: 285-96(1963). 40p. CFSTI.

Two articles are included which treat the deformation of Mo single crystals. A separate abstract was prepared for one article dealing with slip planes in the plastic deformation of Mo. The other paper, dealing with recrystallization textures in cold-rolled Mo, was previously abstracted as NSA 19: 9718. (D.L.C.)

For an abstract of the individual paper see: 18471.

18471 (FTD-TT-64-371(p.1-20)) A STUDY OF THE PLASTIC DEFORMATION OF SINGLE CRYSTALS OF MOLYBDENUM. Pang-Hsin Chou. (Translation).

Metallographic and x-ray techniques were used to investigate twenty-four molybdenum single crystals of various orientations after extension at −80°C (−50°C), 27°C, 1,000°C, and 2,000°C. The results of investigation indicate that such observable slip traces as {112}, {123}, {145}, etc. are associated with the conjugate slips on two sets of nonparallel {110} planes along a common ⟨111⟩ direction. When the actual slip planes remain the densely packed {110} planes, the apparent slip plane (defined by slip traces) varies with the orientation of a specimen. At different temperatures of extension, the apparent slip plane may or may not vary for a specimen depending on the specific orientation of the specimen. (auth)

18472 (JPRS-28739) POWDER METALLURGY OF SOME RARE AND RARE-EARTH METALS. Translation of p.94-117 from "Redkie i Redkozemel'nye Elementy v Tekhnike," Kiev, 1964. 32p. (TT-65-30320). $2.00 (CFSTI).

The carbides of Y, Sc, and La were prepared by carbon reduction of the oxides in vacuum. The reactions and resulting compositions in the preparations were studied in detail. Properties of Y carbides and ScC–TiC mixtures were measured. The formation kinetics and properties of the nitrides of Ti, Zr, Hf, V, Nb, Ta, Cr, and Mo were studied, and the results are tabulated. A review is presented of the production, properties, and analysis of rare-earth phosphides and sulfides. (D.L.C.)

18473 (JPRS-28859) MODERN METHODS OF INCREASING THE STRENGTH PROPERTIES OF STEELS AND ALLOYS. I. M. Pavlov, G. N. Mekhed, and Yu-Ming Wang. Translated from p.3-18 of "Plasticheskaya Deformatsiya Metallov," Moscow. 1964. 22p. (TT-65-30375). $1.00(CFSTI).

The various methods of increasing the strength of metals and alloys are outlined. The several strength types of steels are discussed. The possibility of increasing the strength by increasing the number of dislocations in the crystal lattice is considered. Thermomechanical processing as a means of increasing the dislocation number is discussed in detail. The effects of alloying, plastic deformation temperature, supercooled austenite, quenching rate, etc., on the resulting mechanical properties are described. Finally, thermomechanicomagnetic processing (quenching in strong magnetic field) is considered. (D.L.C.)

18474 CONTRIBUTION TO A STUDY OF THE MECHANISM OF THE KINETIC TRANSFORMATION $\delta \rightarrow \gamma$ IN PLUTONIUM. B. Hocheid, A. Tanon, and F. Miard (Centre d'Etudes Nucleaires, Saclay, France). Acta Met., 13: 144-7(Feb. 1965). (In French)

The $\delta \rightarrow \gamma$ transformation on cooling was followed by dilatometry under secondary vacuum and by micrography with particular examination of the fracture period. The results showed that a decrease in cooling velocity increases the proportion of the δ phase transformed into the γ phase during the fracture period. The transformation can progress during maintenance of constant temperature. Successive cycles of heating and cooling showed that the aspect of the transformation did not vary from one cycle to the other. There was significant modification of the behavior of the plutonium, if during one of the cycles, the transformation was effected by an isothermal treatment of long duration. Two hypotheses, which appear able to explain the behavior observed, are discussed. (J.S.R.)

18475 GAS TRANSPORT CHARACTERISTICS OF URANIUM-FUELED GRAPHITES. A. P. Malinauskas and F. L. Carlsen, Jr. (Oak Ridge National Lab., Tenn.). Am. Ceram. Soc. Bull., 44: 251-7(Mar. 1965).

Gas flow characteristics of both uncoated and pyrolytic carbon-coated uranium carbide admixed graphites were investigated. Effective diffusion coefficients for the gas pair He–Ar and permeability coefficients for the gases He, Ar, N_2, and CO_2, as determined with one of the uncoated fuel admixtures, verified the applicability of the gas transport expressions to such materials. Permeabilities to argon were employed to determine sample uniformity, orientation effects (relative to the direction of the applied molding force), and the effects of uranium concentration in specimens containing the uncoated uranium carbide. Correlation of the permeability curves with pore-size spectra determined for the graphites gave good agreement, whereas a comparison of the surface areas measured by the nitrogen adsorption (B.E.T.) method with the values calculated from the gas flow properties showed marked deviations. (auth)

18476 THE EFFECTS OF ELECTRON-ELECTRON INTERACTION ON THE PROPERTIES OF METALS. T. M. Rice (Cambridge Univ., Eng.). Ann. Phys. (N. Y.), 31: 100-20(Jan. 1963).

The magnitude of the effects of the Coulomb interaction between the electrons in an electron gas at metallic densities is estimated for a variety of phenomena. The calculations are based on an approximation suggested by Hubbard and are presented in the framework of the Landau theory. The effective mass, the Pauli spin susceptibility, and the compressibility are estimated and are compared with the experimental results and with previous calculations. The quasi-particle renormalization factor and the interaction energy between two quasi particles on the Fermi surface—the Landau f(p,p')—are also evaluated in this approximation. The proper vertex part is calculated to lowest order in the dynamically screened interaction. (auth)

18477 ORDERED DOMAINS AND THE c/a RATIO OF $Ta_{44}C$. R. Villagrana and G. Thomas (Univ. of California, Berkeley). Appl. Phys. Letters, 6: 61-2(Feb. 15, 1965). (UCRL-11744(Rev.))

Samples of Ta containing on the order of 1.5% C were studied by electron microscopy and diffraction. Evidence

for the presence of tetragonal domains was observed; and a value of c/a = 1.08 was obtained, using a hard-sphere model. (D.C.W.)

18478 DIFFUSION OF H_1^+ HYDROGEN IONS IN STAINLESS STEEL SURFACE. E. S. Borovik, N. P. Katrich, and G. T. Nikolaev. At. Energ. (USSR), 18: 91-6(Feb. 1965). (In Russian)

An installation used for determining the coefficient of a hydrogen ion H_1^+ diffusion at 35 kev is described. The use of hydrogen and helium condensation pumps secure an ultrahigh vacuum in the installation. The diffusion constant for ion density of 10^{13} to 2×10^{13} is 0.93 and does not depend on the number of diffused ions. (tr-auth)

18479 THE BEHAVIOR OF FISSION PRODUCTS CAPTURED IN GRAPHITE POWDER BY NUCLEAR RECOIL. VIII. FURTHER STUDIES OF IODINE-131 DIFFUSED OUT OF GRAPHITE. Seishi Yajima, Koreyuki Shiba, and Muneo (Tohoku Univ., Sendai and Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 38: 278-81(Feb. 1965).

Diffusion of ^{131}I from ceramic fuels is discussed. The combining of ^{131}I with fissionable materials was proved. Uranium tetraiodide was prepared, and its behavior compared with that of ^{131}I by using a thermochromatograph. The UI_4 deposited on the same place in a thermochromatotube as the fission ^{131}I, in an inert gas atmosphere. The behavior of UI_4 toward oxygen was the same as that of fission ^{131}I. (M.C.G.)

18480 ALTERNATING CURRENT CHARACTERISTICS OF Nb–Zr SUPERCONDUCTING COILS. Kazuhiko Hidaka, Hiroshi Miyata, Koichiro Shinada, Seijiro Ihara, and Takehiro Sekine (Electrotechnical Lab., Tokyo). Denki Shikensho Iho, 28: 561-76(Aug. 1964).

Commercial frequency alternating current was applied to several kinds of coils composed of Nb–Zr superconductive wires of 0.01 and 0.02 in. dia with or without iron cores. The critical current, power loss, time interval required for restoring superconductivity, and duration time of fault current at short-circuit of the secondary coil of a superconducting transformer when the value of the prospective short-circuit current exceeded that of the critical current were measured. The dependency of the critical current on the magnetic flux density around the element wire was shown. Of the Nb–Zr wire of 0.01 in. dia, the resistivity at low current density was 3.0×10^{-11} ohm-cm, increasing with increasing current density, and the time for a sample coil to restore superconductivity was about 40 cycles. The duration time of fault current depended on the ratio of the prospective current to the critical current. It was less than a half cycle when the former current was 1.5 times of the latter one. (auth)

18481 CRYSTAL STRUCTURES OF THE COMPOUNDS Ce_2Co_{17}, Y_2Co_{17} AND Y_2Fe_{17}. O. S. Zarechnyuk and P. I. Krypyakevich (Lvov State Univ.). Dopovidi Akad. Nauk Ukr. RSR, No. 12, 1593-5(1964). (In Ukrainian)

By means of x-ray diffraction analysis structures of the Th_2Ni_{17} type were found for the compounds Ce_2Co_{17} (a = 8.38, c = 8.12 Å, c/a = 0.969) and Y_2Co_{17} (a = 8.36, c = 8.16 Å, c/a = 0.976), as well as for the compound Y_2Fe_{17} ("YFe_9", a = 8.49, c = 8.32 Å, c/a = 0.981). (auth)

18482 INTERNAL FRICTION OF POLYCRYSTALLINE OR MONOCRYSTALLINE TUNGSTEN EXPOSED TO A FLEXION VIBRATION MODE. Bernard Secretan (Universite, Lausanne, Switzerland). Helv. Phys. Acta, 37: 699-721(1964). (In French)

The characteristics of an installation making possible the measurement, as a function of the deformation between −200 and +550°C, the internal friction of metallic bars exposed to a flexion vibration mode in the region of a khertz are described. The differences in the internal friction of polycrystalline or monocrystalline bars formed by fritting, fusion, or drawing by the Czochralski technique were studied. One series of isochron anneals of 4 hr made on each sample by steps of 50 to 100°C between 50 and 2000°C showed simple or double internal friction peaks at low temperature (−155 and −85°C). These peaks were interpreted on the basis of the Seeger model by taking account of the kinks. The increase of the internal friction between 20 and 550°C was attributed to a relaxation process in which the impurities were entrapped by stresses appearing around a motion dislocation. The variation of the internal friction as a function of the deformation between 10^{-9} and 10^{-5} seemed to result from the blocking of the dislocations by the impurities. The residual internal friction measured after annealing at 2000°C, after which all the faults were restored, can be explained by the energy losses from thermoelastic coupling. (tr-auth)

18483 ELASTIC CONSTANTS OF RHENIUM SINGLE CRYSTALS IN THE TEMPERATURE RANGE 4.2°-298°K. M. L. Shepard and J. F. Smith (Ames Lab., Ames, Iowa). J. Appl. Phys., 36: 1447-50(Apr. 1965). (IS-988)

The five independent elastic constants of single crystals of hexagonal close-packed rhenium were determined by the ultrasonic pulse-echo technique over the temperature range 4.2–298°K. The values at 298°K in units of 10^{11} dyne/cm^2 are C_{11} = 61.25, C_{33} = 68.27, C_{44} = 16.25, C_{12} = 27.0, and C_{13} = 20.6. The bulk modulus derived from these constants shows a temperature variation somewhat analogous to that which was reported for other 4d-5d transition metals. The Debye temperature calculated from the elastic constants at 4.2°K is 416.2°K. (auth)

18484 VACANCIES AND DISLOCATION LOOPS IN QUENCHED CRYSTALS OF GRAPHITE. Gerhart Hennig (Argonne National Lab., Ill.). J. Appl. Phys., 36: 1482-6 (Apr. 1965).

The distribution of vacancies and dislocation loops in quenched graphite was studied by etching and decorating individual vacancies. Quenching in inert gases from 3100°C introduced less than 10^{-6} vacancies per atom, and no dislocation loops. After quenching in vacuo from 3100°C, large portions of the crystals contained less than 10^{-10} vacancies per atom, but most peripheral regions contained an abundance of vacancies and dislocation loops. A probable mechanism for vacancy injection and subsequent coagulation was deduced. It is concluded that the energy of vacancy formation in graphite is larger than 6.6 ev. (auth)

18485 THE PLUTONIUM–OXYGEN PHASE DIAGRAM. E. R. Gardner, T. L. Markin, and R. S. Street (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 27: 541-51(Mar. 1965).

The plutonium – oxygen phase diagram between $PuO_{1.5}$ and PuO_2 and between room temperature and 900°C was studied using a high-temperature x-ray powder-diffraction camera. At temperatures below 300°C, α-Pu_2O_3 and $PuO_{1.98}$ are in equilibrium; the O/Pu ratio of α-Pu_2O_3 is 1.515. Above 300°C, α-Pu_2O_3 takes up oxygen and forms a cubic phase with an O/Pu ratio of 1.61, which is in equilibrium with $PuO_{1.98-x}$. Measurement of lattice parameters as a function of temperature showed that the eutectoid at $PuO_{1.71}$, postulated by previous workers, does not exist. For O/Pu ratios < 1.61 and t > 350°C, hexagonal Pu_2O_3 and cubic $PuO_{1.61}$ are in equilibrium. The upper O/Pu ratio limit of hexagonal Pu_2O_3 is 1.51, and hexagonal Pu_2O_3 remains single phase from room temperature to at least 900°C. Between $PuO_{1.51}$ and $PuO_{1.515}$ at t < 300°C, two very narrow phase regions must be present to satisfy the phase rule. The Pu-O phase diagram showed very little similarity to the rare earth oxygen phase diagrams at t < 600°C. (auth)

18486 SOME OBSERVATIONS ON THE DUCTILITY OF ZIRCONIUM ALLOYS, WITH SPECIAL REFERENCE TO THE EFFECT OF HYDROGEN. Gustaf Oestberg (Aktiebolaget Atomenergi, Stockholm). J. Inst. Metals, 93: 223-8(Mar. 1965).

The influence on Zircaloy-2 of various embrittling factors in mechanical testing was examined by means of microfractography of impact specimens, tensile tests at different temperatures and strain rates, and delayed-failure tests. It was found that the impact test is not suited for distinguishing brittle-to-ductile transistors in Zircaloy-2.

Low-strain-rate embrittlement was detected in Zircaloy-2 and some other zirconium alloys, in the latter case when tested by static loading. These effects were interpreted in terms of hydrogen embrittlement. The occurrence of a yield point was also observed and related to the hydrogen content. The influence of texture, particularly with regards to the appearance of several load maxima and multiple necking, is discussed. (auth)

18487 AN EFFECT OF THERMAL CYCLING UPON THE DUCTILITY TRANSITION IN ALPHA-URANIUM. D. M. R. Taplin and J. W. Martin (Univ. of Melbourne). J. Inst. Metals, 93: 230-2(Mar. 1965).

Heat treatments were carried out on reactor-grade, magnesium-reduced uranium to produce variations in grain-boundary energy (γ_B) but to avoid any possible variation in surface energy per unit area of the fracture surface (γ_s) as a result of impurity segregation. After a small number of thermal cycles between −196 and 75°C, mechanical twins became profuse in alpha-uranium. However, no grain-boundary effects were visible after these treatments. Results demonstrated that the raising of the tensile transition temperature is attributable to grain-boundary cracking. This is caused by an increase in γ_B in selected areas by thermal cycling. (M.C.G.)

18488 CONCRETE FOR RADIATION SHIELDING. A STUDY USING THE AGGREGATES FROM THE TOHOKU DISTRICT. Fusayoshi Kawakami and Yukimasa Goto (Tohoku Univ., Sendai). J. Japan Soc. Civil Engrs., 48: No. 11, 16-23(Nov. 1963). (In Japanese)

A study was made of the radiation-shielding effects of a heavy concrete containing various aggregates (from the Tohoku district) such as magnetite, hematite, paigeite, and magnetite sand. It was found that the density, workability, etc., of the concrete are largely influenced by the grade of aggregate. Use of a combination of two kinds of aggregate, the finer aggregate being of greater specific gravity, was found to be effective in decreasing the segregation ane enhancing the uniformity of concrete. Gamma (^{60}Co) penetration tests were made on the concrete using the above combination. It was found that the best γ shielding characteristics were obtained when using magnetite and magnetite sand as the finer aggregate and magnetite as the grosser aggregate. The following linear relation between μ(linear absorption coefficient) and ρ(specific gravity of the concrete) was obtained: $\mu = 0.0521\rho + 0.0098$. The tests were also effective in examining the degree of segregation of the concrete. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

18489 THERMAL EXPANSION OF $LaRu_2$, $CeRu_2$, AND $PrRu_2$ FROM 20° TO 900°C. K. A. Gschneidner, Jr., R. O. Elliott, and D. T. Cromer (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals, 8: 217-21(Apr. 1965). (LA-DC-6729)

The lattice parameters of $LaRu_2$, $CeRu_2$, and $PrRu_2$ were measured from approximately 20 to 800, 900, and 650°C, respectively. The lattice parameters expanded smoothly and continously as the temperature was increased. $CeRu_2$, however, expanded at a much greater rate than either $LaRu_2$ or $PrRu_2$. This greater rate was thought to be due to the transfer of 0.07 electron from the valence band to a one-electron 4*f* band by thermal excitation. (auth)

18490 SOME OBSERVATIONS OF MECHANICAL TWINNING IN POLYCRYSTALLINE NIOBIUM. K. Farrell and P. R. V. Evans (Illinois Inst. of Tech., Chicago). J. Less-Common Metals, 8: 222-34(Apr. 1965).

Twin formation and a competitive nature of deformation by slip and by twinning were studied in coarse-grained polycrystalline niobium tested in tension at −196°C. Twin formation appeared to be easier than twin propagation. Grain boundaries may be good sources for twin nucleation. Twins were often found in the absence of corresponding discontinuities on the stress-strain curve. Room-temperature prestrain was found to inhibit low-temperature twinning; this effect was pronounced only for prestraining beyond the upper yield stress. Ageing after prestraining restored the low-temperature propensity for twinning. (auth)

18491 QUALITATIVE RELATIONS BETWEEN THE SINTERING KINETICS WITH HYDROGEN OF URANIUM DIOXIDE AND THE OBSERVED MICROSTRUCTURE. B. Francois, R. Delmas, R. Caillat, and P. Lacombe (Commissariat a l'Energie Atomique, Paris). J. Nucl. Mater., 15: 105-10(1965). (In French)

Micrographic studies of uranium dioxide sintered under hydrogen, associated with measurements of density, showed that the massive appearance and immobilization during sintering of the pores at the grain boundaries have the effect of practically stopping the densification. This particular microcrystalline facies is stable in a wide range of time and temperature. (tr-auth)

18492 DETERMINATION OF THE MAJOR SLIP PLANE OF ALPHA PLUTONIUM. B. Spriet (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Nucl. Mater., 15: 113-16(1965). (In French)

In order to detect the major slip plane of α-Pu, samples preferentially oriented with the face perpendicular to the axis of the pressure were deformed by compression. When the pressure applied was perpendicular to the (020) planes, the deformation was produced only by slips at the grain boundaries and deviated slips. The sample was then deformed by bending following an axis parallel to the (020) planes. The absence of all other systems of secondary slip confirmed that α-Pu has the (020) plane as the major slip plane at room temperature. (J.S.R.)

18493 SOME OBSERVATIONS RELATIVE TO THE EFFECT OF A CONTROLLED FUSION ON Al−Al_2O_3 MIXTURES. G. Beghi and G. Piatti (EURATOM-CCR, Ispra, Italy). J. Nucl. Mater., 15: 117-20(1965). (In French)

The effects of fusion on SAP-ISML with 7% Al_2O_3 were studied by thermal treatment at 685°C (just below the fusion point of Al) for periods of 1, 2, 5, and 10 hrs. The material was then extruded at 500°C. Microscopic examination showed that the structure after fusion and extrusion was analogous to that of normal SAP, with a fine dispersion of oxide in the Al matrix, which was homogeneous throughout the extruded bars. There was no change in the matrix stability and no growth of the Al grains. Rupture tests were made at room temperature and at 450°C. There was no significant difference between the untreated samples and the thermally treated and extruded samples. (J.S.R.)

18494 DIFFUSION STUDIES IN THE SYSTEM URANIUM-ZIRCONIUM. STUDY OF URANIUM-ZIRCONIUM MIXED CARBIDES. J. Kutka, I. Quaeck, and M. Schenk (Zentralinstitut fur Kernforschung, Rossendorf, Ger.). J. Nucl. Mater., 15: 129-32(1965). (In German)

Diffusion research was carried out on uranium-zirconium metallic pairs, in which commercial uranium with 0.04 wt % C was used. After diffusion glowing for 305 hr at 950°C and 135 hr at 550°C, there arose, not the intermediary phase existing in the system, but a (Zr, U)C mixed carbide with cubic face-centered lattice with the lattice constant $a_0 = 4.6805 \pm 0.0005$ Å. When the residual gas remaining in the quartz ampule was eliminated by a uranium turning getter, there arose at a vacuum of 3 to 1×10^{-6} Torr a single homogeneous diffusion layer of the mixed carbide. When the samples were glowed at a vacuum of 5×10^{-3} to 1×10^{-4} Torr, a second irregular transparent layer, which could not be identified, was detected. (tr-auth)

18495 PROGRESS IN ANNEALING OF MECHANICAL PROPERTIES OF ROLLED URANIUM. Nelly H. Ambrosis de Libanati and Sara Volman de Tanis (Comision Nacional de Energia Atomica, Buenos Aires). J. Nucl. Mater., 15: 153-63(1965). (In French)

The mechanical behavior of uranium after cold-rolling and annealing was studied by metallography and by tensile tests. It was found that partially recrystallized structures, which show a striated structure under the microscope, were the most ductile. Examination of the deformation of different structures obtained by annealing showed that this phenomenon is connected with the recrystallization mechanism of uranium and not with the behavior of impurities. It is

thus considered possible to produce by annealing structures with various mechanical properties. The start of recrystallization was very heterogeneous and led to banded structure. These bands deformed like an ensemble of small grains with slight mutual misorientations. Recrystallization proper, characterized by the change in the expansion coefficient and by the disappearance of the bands, produced fine grain structures without preferred orientation; these structures were less ductile. The study of the cold-rolling of uranium of various impurities after partial recrystallization showed that the ductility found by tensile tests is accompanied by a greater capacity for rolling reduction. (auth)

18496 PROPERTIES OF PLUTONIUM IN THE ALPHA-BETA TRANSUS REGION. Edward G. Bodine, Martin S. Farkas, and William M. Pardue (Battelle Memorial Inst., Columbus, Ohio). J. Nucl. Mater., 15: 184-8(1965).

Kinetics of the initiation of the alpha-to-beta transformation in plutonium metal were determined by measurements of electric resistivity, both unstressed and under an applied load. It was demonstrated that the speed of the transformation increases with metal purity and that an applied stress of approximately 12,000 psi did not affect the transformation kinetics. In addition, mechanical properties were measured for plutonium at 118 and 124°C. (auth)

18497 AN ANALYSIS OF CREEP DUCTILITY OF MAGNOX AL80 AND ITS IMPLICATIONS. J. E. Harris (Central Electricity Generating Board, Berkeley, Glos., Eng.). J. Nucl. Mater., 15: 201-7(1965).

The ductility-temperature relationships for polycrystalline magnesium–0.8 wt % aluminum–0.005 wt % beryllium alloy is explained using the Stroh relationship and theories of cavity formation based on heterogeneous nucleation at particles and subsequent growth by vacancy condensation. Forecasts are made on the behavior of this alloy under reactor service conditions and various possible methods of improving its properties are discussed. (auth)

18498 THE EFFECT OF HYDROGEN ON THE EMBRITTLEMENT OF ZIRCONIUM-BASE PRESSURE TUBES. M. Farrow and B. Watkins (United Kingdom Atomic Energy Authority, Culcheth, Warrington, Lancs, Eng.). J. Nucl. Mater., 15: 208-19(1965). (TRG-Report-774)

The effects of hydrogen on the brittleness of Zircaloy-2 and zirconium–2½% niobium pressure tube alloys were studied. Conventional Charpy impact test specimens cut from plate materials were used to determine the effect of 100 ppm hydrogen. It was found that widely differing results are obtained by altering the specimen and notch orientations. Therefore, a drop weight test was developed to assess the brittleness of actual pressure tube sections; this test is described and preliminary results presented. (auth)

18499 VISCOSITY, DENSITY, AND LIQUIDUS TEMPERATURE OF MOLTEN Pu–1 WT % Ga ALLOY. Donald Ofte and W. G. Rohr (Monsanto Research Corp., Miamisburg, Ohio). J. Nucl. Mater., 15: 231-3(1965). (MLM-1226-J)

The viscosity, density, and liquidus temperature of a molten Pu–1 wt % Ga alloy are reported and compared with the same properties of unalloyed plutonium. The absolute viscosity of the molten alloy was measured at 12 temperatures from the 669°C liquidus temperature to 816°C in an oscillating cup viscometer. A vacuum pycnometric technique was used to measure the density at 7 temperatures between 682 and 847°C. The viscosity was found to decrease linearly with increasing temperature from 8.84 to 6.50 centipoise in the range studied. The liquid density decreased from 16.18 to 16.01 g/cm^3 in the temperature range studied. Data are presented in tables and graphs. (M.C.G.)

18500 NON-BASAL GLIDE IN GRAPHITE. J. M. Thomas and C. Roscoe (University Coll. of North Wales, Bangor, Wales). J. Nucl. Mater., 15: 245-6(1965).

It was found that when graphite crystals are oxidized by molecular oxygen in the presence of minute traces of added boron, there is an enhanced tendency for etch pits to be nucleated at the regions of emergence of those dislocations, which lie in $\{11\bar{2}1\}$ and $\{10\bar{1}1\}$ planes. (M.C.G.)

18501 STRUCTURE OF OXIDES OF NIOBIUM: TRANSFORMATION OF THE γ-Nb_2O_5 STRUCTURE TO α-Nb_2O_5 AND THE FORMATION OF NbO_2. Nobuzo Terao (Union Carbide European Research Associates, s.a., Brussels). Japan. J. Appl. Phys., 4: 8-15(Jan. 1965). (In French)

The formation of several intermediate oxides of niobium, produced in the course of the transformation γ-$Nb_2O_5 \rightarrow \alpha$-$Nb_2O_5$ and the reaction $Nb_2O_5 + Nb \rightarrow NbO_2$, was studied by x-ray diffraction. The structure transformation $\gamma \rightarrow \alpha$ was accomplished by passage through two intermediate stages, γ' and β. The γ' form was interpreted to have a monoclinic lattice with parameters a = 7.34, b = 5.96, c = 13.64 Å, and β = 115°30′. The γ form was previously considered to be a pentoxide having $12Nb_2O_5$ molecules in its elementary lattice. The helium method of density measurement showed, however, two possibilities for the composition of the γ form. These are either a pentoxide, which has $14Nb_2O_5$ molecules in its elementary lattice or $Nb_{28}O_{69}(NbO_{2.464})$. The form II, which was observed in the transformation $Nb_2O_5 \rightarrow NbO_2$ and reported previously was confirmed to be $Nb_{12}O_{29}(NbO_{2.417})$. (auth)

18502 THERMOELECTRIC FORCE OF HOT ELECTRONS AND ELECTROCONDUCTIVITY OF GERMANIUM IN THE REGION LOW ELECTRIC FIELDS. K. Repsas and J. Pozela (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstrosios Mokyklos, 4: 485-90(1964). (In Russian)

The variation of the mobility and the thermo-electric force of hot carriers with applied electric fields up to 400 v cm^{-1} was determined. It is shown that the temperatures of hot carriers evaluated from these two effects are in qualitative agreement. (auth)

18503 THE CRYSTAL STRUCTURE OF U_2Cr_3Si, $U_4Mn_6Si_3$, AND U_2Co_3Si. J. B. Kusma and H. Nowotny (Universitat, Vienna). Monatsh. Chem., 95: 1219-24(1964). (In German)

Mixtures of the composition $U(T,Si)_2$ and $U(T,Al)_2$, where T = Ti, V, Cr, Mn, Co, Nb, W, and with at. % of Si = 10, 17, 25, or 33, were examined. Powder patterns of some alloys in the systems U–Cr–Si, U–Mn–Si, and U–Co–Si showed the presence of a $MgZn_2$ type in each; these compounds were prepared in a homogeneous state and found to be U_2Cr_3Si, $U_4Mn_6Si_3$, and U_2Co_3Si. Lattice parameters were: for U_2Cr_3Si, a = 5.125, c = 8.265, c/a = 1.613; for $U_4Mn_6Si_3$, a = 5.168, c = 7.908, c/a = 1.530; and for U_2Co_3Si, a = 5.139, c = 7.585, c/a = 1.476. The intensities were calculated for the positions in the Mn compound, and compared with the values found in a Debye-Scherrer plot to give good agreement. Heating to 800°C reduced the region of homogeneity of U_2Cr_3Si considerably. For the three phases U_2Cr_3Si, $U_4Cr_5Si_3$, and UCrSi, different parameters exist and are tabulated, but only a slight volume contraction for the new compound is noted. Interatomic distances for these compounds showed no change in coordination from the $MgZn_2$ type even though the c/a ratios were small; a table of interatomic distances is given together with those in U_2Fe_3Si for comparison. (BBB)

18504 OPTICAL PROPERTIES OF URANIUM OXIDES. J. M. Jones and D. G. Murchison (Univ. of Newcastle-upon-Tyne, Eng.). Nature, 205: 663-5(Feb. 13, 1965).

An investigation was made on the optical properties of uranium oxides in the composition range $UO_{2.00}$–$UO_{2.25}$. It was hoped to establish: that a satisfactory correlation existed between the optical properties of the oxides and their oxygen/metal ratios; and if this were the case, that the method employed could give a sensitivity of ±0.01 on the oxygen/metal ratios, particularly in the examination of sintered pellets and powders. The results obtained thus far are encouraging and suggest that both aims stated will be fulfilled. Reflectivities in air of three sinters with dif-

ferent O/M ratios, and one set of pure single crystals, were measured at 4030, 4480, 5020, 5900, 6520, and 7090 A. The results showed that for the uranium oxides the maximum change of reflectivity with O/M ratio occurs towards the extremes of the visible spectrum with much less differentiation around 5000 A. The results so far suggest that, even with the tungsten lamp and its low efficiency at this wavelength, the desired differentiation between the different sintered oxides will be achieved. (P.C.H.)

18505 ELECTROSTATIC SWITCHING OF ONE-DIMENSIONAL SUPERCONDUCTORS. David L. Atherton (Ferranti Electronics, Toronto). Nature, 205: 687(Feb. 13, 1965).

Discussion is presented on the previous speculation (Little, W. A., Phys. Rev., 134: A1416(1964)) on the possibility of synthesizing an organic superconductor. The type of macromolecule required is essentially a long-chain organic polymer. It is suggested that preferential orientation of the molecules along the macromolecule axis would be relatively simple to synthesize by the nylon spinning technique, and if coupling between molecules can then be arranged, a long thread of superconductor could be produced. The effects of an electric field applied across a superconducting thread would be to distort the screening effects of the side-chain and to modify the wave functions of the side-chain; the side-chain interaction will be altered and superconductivity will eventually be destroyed. There is, therefore, the possibility of electrostatically switching a one-dimensional superconductor into its normal resistive state as well as the customary magnetic switching effects. Uses for the organic macromolecular superconductor are suggested. (P.C.H.)

18506 DIRECT EVIDENCE FOR THREE TRANSFORMATION MECHANISMS FOR THE $\beta \rightarrow \alpha$ PHASE CHANGE IN URANIUM–CHROMIUM ALLOYS. R. D. Townsend and J. Burke (Univ. of Liverpool). Nature, 205: 794-5(Feb. 20, 1965).

Changes in resistivity accompanying the $\beta \rightarrow \alpha$ phase change in Cr-U alloys were measured continuously using the potential drop method, the potential across the specimen being recorded on a potentiometric strip chart recorder. No results could be obtained between 560 and 585°C because the magnitude of the resistance change in this range was too small to give reasonable sensitivity. It was found that the β-phase can transform to α by three mechanisms. The complete time-temperature-transformation diagram derived from the resistivity measurements is illustrated showing the curves, which are labeled C_1, C_2, and C_3. This shows that increasing the Cr content from 0.5 to 0.85% depresses C_3 much more than C_2 and produces a marked separation between the C_2 and C_3. It is therefore suggested that the closer proximity of the two upper C-curves indicates that the mechanism in C_2 is more akin to the known diffusional reaction in C_1 than to the martensitic reaction in C_3. This indicates that the phase change in C_2 involves diffusion as the predominant process. (P.C.H.)

18507 THE ABILITY OF BUILDING MATERIALS TO ABSORB HEAT AND RADIOACTIVE RADIATION. W. Lojander, Antti Mattila, K. Rosendahl, and G. Wendt (Helsinki Univ.). Nord. Hyg. Tidskr., 42: 221-8(1961). (In Swedish)

Gamma absorption by commonly used building materials was determined and compared with heat transmission capacity. Nineteen different materials were tested; including cement, glass, plastics, and other synthetic materials, using ^{60}Co and Ra as sources of ionizing radiation. Transmission of γ radiation by the materials was measured in a lead chamber using a NaI(Tl) crystal. Heat transmission was measured in terms of k values (kcal/m^2 × h × °C). The results showed that the heat transmission ability generally decreases with an increase in the capacity for absorbing γ rays. It was further observed that, although the absorption coefficient varies for the different materials, wall thickness is the essential factor from the point of view of protection from ionizing radiation. The results show that some building materials, which fulfill certain conditions in regard to protection from γ rays, show an increase in protection with decreasing k value. A chart is given which allows immediate selection of the materials having both the required thermotechnical qualities and giving adequate protection from radiation. The importance of distance in the protection from ionizing radiation is emphasized. (BBB)

18508 HIGH DENSITY SLAG CONCRETE. T. E. Northup (Oak Ridge National Lab., Tenn.). Nucl. Struct. Eng., 1: 347-51(Mar. 1965).

A waste slag material with a specific gravity of 3.80, derived from the lead smelting industries, was investigated to evaluate its availability, quality variations, price stability, handling methods and equipment required, and shipping methods and limitations. The effect of the slag on concrete mixes was evaluated for workability, setting characteristics, compressive strength, and unit weight. Data are presented in graphs. On a pound-for pound-of-shielding basis, the materials for waste lead-slag concrete were found to be 30% cheaper than materials for barytes and magnetite concretes. (M.C.G.)

18509 HIGH-TEMPERATURE TRANSPORT PROPERTIES OF ALKALI METAL VAPORS. R. H. Davies, E. A. Mason, and R. J. Munn (Univ. of Maryland, College Park). Phys. Fluids, 8: 444-52(Mar. 1965).

Estimates of the potential-energy curves for the interaction of ground-state alkali metal atoms were obtained from available spectroscopic data and a semi-empirical scaling procedure. From these curves the transport collision integrals for monatomic alkali-metal vapors were calculated over the temperature range 1000 to 10,000°K. Collision integrals for the diffusion of alkali-metal ions through their parent monatomic vapors were calculated over the same range from estimates of the charge-exchange cross sections, obtained by a scaling procedure based on the experimental measurements for cesium. Comparison with limited existing experimental data on second virial coefficients, viscosities, thermal conductivities, and charge exchange was made, and the collision integrals estimated to be uncertain by about 25%. (auth)

18510 THE THERMAL CONDUCTIVITIES OF SCANDIUM AND SOME RARE EARTH METALS. R. W. Powell B. W. Jolliffe (National Physical Lab., Teddington, Middx., Eng.). Phys. Letters, 14: 171-2(Feb. 1, 1965).

Thermal conductivity and electric resistivity measurements were made on polycrystalline samples of Sc, Ce, Dy, Er, Gd, Ho, Nd, Sm, and Tb, at 18°C. Results for thermal conductivities, using the direct reading and two-ball thermal comparator methods, and for the electric resistivities, using the four-probe method, are tabulated along with the values of the Lorentz function. (L.B.S.)

18511 LOCALIZED MOMENTS ASSOCIATED WITH VERY DILUTE Fe IMPURITIES IN SOME TRANSITION AND NOBLE METALS. T. A. Kitchens, W. A. Steyert, and R. D. Taylor (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 138: A467-83(Apr. 19, 1965). (LA-DC-6767)

The magnetic behavior of very dilute (< 0.1%) iron impurities in Cu, Ag, Au, V, Nb, Ta, Mo, W, Rh, and Pt was studied by the Mössbauer effect in ^{57}Fe for applied fields to 62 kOe and temperatures from 0.5 to 300°K. For V, Nb, and Ta the hyperfine field at the impurity nucleus corresponds directly to the applied field to within 1.5 kOe; no localized moment exists. For the other metals, an internal field is found which is antiparallel to the applied field. The functional behavior of the internal fields is analyzed in terms of localized magnetic states associated with the Fe impurities, which do not interact with one another, but are not, in general, completely free. The localized magnetic moments, which range to 6.0 μ_B, can be correlated with the average concentration of electrons outside the last full shell, and agreed with the moments derived from available magnetic-susceptibility measurements. Temperature and chemical shifts for these sources are given. (auth)

18512 MAGNETOSTRICTION OF Tb SINGLE CRYSTALS. J. J. Rhyne and S. Legvold (Ames Lab., Ames, Iowa). Phys. Rev., 138: A507-14(Apr. 19, 1965). (IS-1013)

The magnetostriction of Tb single crystals was measured from 4 to 350°K in applied fields up to 30 kOe by strain-gage methods. The temperature dependence of the four magnetostriction constants was determined under the assumption that the magnetic moment remains in the basal plane. Two of the constants were evaluated by strain measurements as a function of applied-field direction in the basal plane, and the remaining two by isofield magnetostrain measurements and subtraction of the thermal strain extrapolated from the paramagnetic region. The theoretical dependence of the anisotropic basal plane constants on the magnetic moment was evaluated. (auth)

18513 ELECTRON-SPIN RESONANCES IN REACTOR-IRRADIATED ALUMINUM OXIDE. F. T. Gamble (Univ. of Connecticut, Storrs), R. H. Bartram, C. G. Young, O. R. Gilliam, and Paul W. Levy. Phys. Rev., 138: A577-83 (Apr. 19, 1965). (BNL-8666)

Three prominent paramagnetic absorption systems were detected in single crystals of α aluminum oxide (Al_2O_3) following reactor irradiation with and without subsequent low-temperature gamma-ray irradiation. The most prominent system has an asymmetric, slightly anisotropic absorption with $g \approx 2.00$, which appears to result from the superposition of components from several paramagnetic centers. A second system consisting of twelve equally intense lines corresponds to a spin-one center in six inequivalent sites whose z axes are perpendicular to the crystal c axis and nearly parallel to rows of O^{2-} ions. The spin-hamiltonian parameters for this defect are: $g_z = 2.0105 \pm 0.0020$, $g_x = g_y = 2.0190 \pm 0.0020$, $S = 1$, $|D| = 0.0710 \pm 0.0002$ cm^{-1}, and $|E| = 0.0025 \pm 0.0005$ cm^{-1}, where D and E have the same sign. Its spectrum is attributed to an AlO^{3-} molecular ion in a pair of oxygen sites, formed by a replacement collision. The third system is obtained when a reactor-irradiated crystal of Al_2O_3 is gamma-ray irradiated at 77°K and measured prior to warming up. It is a three-line system which saturates with gamma-ray dose but whose saturation level increases with reactor dose. This system corresponds to a spin-$^3/_2$ center with a symmetry axis parallel to the c axis; its spin-hamiltonian parameters are: $g_{||} = 2.018 \pm 0.002$, $g_\perp = 2.011 \pm 0.002$, $S = {}^3/_2$, and $|D| = 0.0373 \pm 0.0002$ cm^{-1}. It is attributed to interstitial O^+ formed from interstitial O^0 by ionization of hole trapping. (auth)

18514 ELECTRON MICROSCOPE TRANSMISSION IMAGES OF COHERENT DOMAIN BOUNDARIES. II. OBSERVATIONS. R. Gevers, P. Delavignette, H. Blank, J. Van Landuyt, and S. Amelinckx. Phys. Status Solidi, 5: 595-633(1964). (BLG-279-II)

The properties of the domain fringe patterns were observed and are illustrated by means of examples. In particular, fringes resulting from ferroelectric domain walls in barium titanate, and antiferromagnetic domain walls in nickel oxide, are discussed. It is shown how, from the natural of the first and last fringes and a knowledge of the diffraction vector, the geometry of the domains on both sides of the domain wall can be deduced. In the case of barium titanate this procedure gives the direction of the tetragonal axes in both domains. In nickel oxide the directions of the contractions due to ferromagnetic ordering can be deduced. In niobium, domains can be produced by the insertion of gaseous interstitial impurities, which leads to a small deformation of the niobium matrix. The walls between such domains show the same type of fringes. The fringe patterns observed by Fourie et al. at twins in tin are discussed. Some numerical calculations based on the exact analytical expressions are compared with the observations and also with the approximate analytical treatment. (auth)

18515 THE CRYSTAL STRUCTURE OF GRAPHITE-BROMINE COMPOUNDS. W. T. Eeles and J. A. Turnbull (Central Electricity Generating Board, Berkeley, Gloucestershire, Eng.). Proc. Roy. Soc. (London), Ser. A, 283: 179-93(Jan. 6, 1965).

Single crystals of naturally occurring graphite which had been treated with Br vapor were examined by electron and x-ray diffraction and by electron microscopy. The intercalated Br is in the form of layers, interleaved between the graphite layers in a sequence which is dependent upon the concentration of Br. The structure within a Br layer is relatively highly ordered and was shown to take on two forms, one which occurs at concentrations in excess of 47 (wt.) %, the other occurring at lower concentrations. Detailed analysis of the diffraction patterns given by the lower concentration form suggest that it is composed of chains of Br_2 molecules, in which the interatomic distances are virtually identical with those of solid Br. (auth)

18516 ANISOTROPY OF THERMAL CONDUCTANCE IN NEAR-IDEAL GRAPHITE. C. N. Hooker, A. R. Ubbelohde, and D. A. Young (Imperial Coll. of Science and Tech., London). Proc. Roy. Soc. (London), Ser. A, 284: 17-31 (Feb. 9, 1965).

Measurements of thermal conductivities of a number of pyrolytic graphites are reported including values for annealed, hot pressed graphite (IFPA57). Thermal conductivities of IFPA57 in both basal plane and c-axis directions approach the values for ideal graphite at higher temperatures. A theoretical estimate of the anisotropy of thermal conduction in ideal graphite in the temperature range where umklapp scattering predominates shows fair agreement with the present experimental value. Such defects as are normally present in well-oriented graphite produce comparatively little effect on the c-axis thermal conductivity; and exposure to neutron damage has a much smaller effect in the direction of the c axis, than in the basal plane direction. (auth)

18517 PHYSICAL AND MECHANICAL PROPERTIES OF ZIRCONIUM–NIOBIUM ALLOYS. J.-J. Huet, D. Quataert, G. Spaepen, and Ph. van Asbroek (Centre d'Etude de l'Energie Nucleaire, Mol-Donk, Belg.). Rev. Met. (Paris), 62: 31-44(Jan. 1965). (In French)

Certain physical properties of zirconium and niobium alloys were determined. Some special points of the Zr–Nb equilibrium diagram were clarified. TTT (time, transition, temperature) curves of alloys containing between 10 and 25% Nb were obtained. The ultimate tensile stress yield point, ductility, and creep strength were measured, and the corrosion resistance was estimated. Among the alloys studied, that containing 17.5% Nb had particularly favorable properties compared with those of Zircaloy-2. (auth)

18518 VISCOSITIES OF LIQUID SODIUM AND POTASSIUM, FROM THEIR MELTING POINTS TO THEIR CRITICAL POINTS. Aristid V. Grosse (Univ. of Philadelphia). Science, 147: 1438-41(Mar. 19, 1965).

The viscosities of liquid sodium and potassium were estimated up to the critical temperatures according to the method recently described for mercury. The critical absolute viscosity of sodium is 0.072 centipoise and that of potassium 0.055 centipoise, the estimated precision being plus or minus 0.01 centipoise. The critical absolute viscosities of metals are higher than those of covalent or homopolar substances of van der Waals type. (auth)

18519 SUPERCONDUCTING GALLIUM ANTIMONIDE. D. B. McWhan (Bell Telephone Labs., Murray Hill, N. J.), G. W. Hull, Jr., T. R. R. McDonald, and E. Gregory. Science, 147: 1441-2(Mar. 19, 1965).

A metallic phase of gallium antimonide, obtained by quenching at approximately 120 kilobars to 77°K and then releasing pressure, is a superconductor. The transition temperature depends on the annealing conditions; for samples annealed at 250°C under pressure before quenching, it is 4.24 ± 0.10°K, and H_{c2} (the critical field) equals 2640 gauss at 3.50°K. This temperature is higher than the 2.1°K reported for metallic indium antimonide. (auth)

18520 MAGNETIC SCATTERING OF NEUTRONS IN CHROMIUM. H. Bjerrum Moeller, K. Blinowski, A. R. Mackintosh, and T. Brun (Atomenergikommissionen, Risö, Denmark and Universitet, Copenhagen). Solid State Commun., 2: 109-14(Apr. 1964).

The results of a study of the magnetic scattering of neutrons in chromium near the Néel temperature are pre-

sented. It is determined from these results that short-range ordering persists in chromium unusually high above the Néel temperature and that the magnetic structure below the Néel temperature can exhibit lower than cubic symmetry. (auth)

18521 THE INTERACTION OF MOLYBDENUM WITH TITANIUM CARBIDE. V. N. Eremenko and T. Ya. Velikanova. Soviet Powder Met. Metal Ceram. (English Transl.), No. 5, 347-52(Sept.-Oct. 1963).

Studies of the interaction of Mo with TiC in the 1.2 to 90 mol % TiC range using x-ray diffraction and metallographic methods are described. A phase diagram is given for the system Mo–TiC, which proves to be quasibinary, with eutectic type of solidification. Data are given on the eutectic composition and the eutectic temperature. Effects of temperature on solubility are discussed. (Rev. Metal Lit., 22: (Jan. 1965))

18522 THE WETTING OF CbC–VC AND CbC–TiC CARBIDE ALLOYS BY NICKEL. V. I. Tumanov, V. F. Funke, and L. I. Belen'kaya. Soviet Powder Met. Metal Ceram. (English Transl.), No. 5, 376-8(Sept.-Oct. 1963).

Effects of composition on the angle of wetting of the solid surfaces of NbC–VC and NbC–TiC systems by Ni were studied. The mechanism of wetting of carbide surfaces by metals, with distortion of the crystal lattice, changes in the ionization of the carbon atoms, and changes in the surface energy of the solid solutions are discussed. (Rev. Metal Lit., 22: (Jan. 1965))

18523 STAINLESS, HEAT-RESISTANT AND HIGH-TEMPERATURE STEELS AND ALLOYS. Karl Bungardt, Helmuth Krainer, and Hans Schrader. Stahl Eisen, 84: 1796-1811(Dec. 17, 1964). (In German and English)

Technical developments and the present state of stainless, heat-resistant, and high-temperature steels and alloys are reviewed. Measures that can be taken from the metallurgical manufacturing, and alloying viewpoints to improve use properties of these steels are discussed. (auth)

18524 DIFFUSION OF TUNGSTEN AND RHENIUM TRACERS IN TUNGSTEN. R. L. Andelin, J. D. Knight, and M. Kahn (Los Alamos Scientific Lab., N. Mex.). Trans. Met. Soc. AIME, 233: 19-24(Jan. 1965). (LADC-5849)

Self-diffusion in single-crystal tungsten and diffusion of rhenium tracer in single-crystal tungsten were measured over the temperature range from 2660 to 3230°C by direct sectioning and radiochemical analysis of ^{185}W, ^{183}Re and ^{184}Re tracers. The initial radioactive layer was produced on the diffusion specimens by bombardment with 9.0-Mev deuterons. Diffusion heating of the samples in high vacuum was accomplished by induction heating. Temperatures were measured by optical pyrometry, and the system was calibrated by reference to the melting points of tantalum (2996°C), molybdenum (2620°C), niobium (2468°C), and rhodium (1966°C). The diffusion coefficients for the two systems, obtained by least-squares analyses of the data, are well-represented by the equations: $D(W) = (42.8 \pm 4.8) \exp[(-153,100 \pm 600)/RT]$ and $D(Re) = (275 \pm 110) \exp[(-162,800 \pm 2500)/RT]$. (auth)

18525 SOLID STATE PLASMA. A. A. Vedenov. Usp. Fiz. Nauk, 84: 533-55(Dec. 1964). (In Russian)

The properties of solid-state plasma are analyzed as functions of the host crystal lattice and of the interaction between the charges and the lattice, as well as phenomena occurring when the plasma in the solid constitutes a subsystem which reacts weakly with the lattice. Expressions are given for the frequency and amplitude of plasma oscillations in metals, semimetals, and semiconductors. This is followed by an analysis of the flow of a charge plasma in a metal of variable cross section, leading to the occurrence of the so-called configurational emf, and flow of neutral plasma in a semiconductor placed in an external magnetic field, leading to a plasma magnetic moment. The stability of laminar flow of solid-state plasma is discussed briefly. Effects connected with the interaction between solid-state plasma and the crystal lattice are discussed. These include change in the sound speed, attenuation or amplification of the sound by interaction with plasma, and appearance of local anomalies on the dispersion curves. Turbulence of solid-state plasma is briefly discussed. Some theoretical and experimental problems which need to be clarified to understand the properties of solid-state plasma are mentioned. (ATD)

18526 THERMODYNAMIC PROPERTIES OF COBALT–NIOBIUM ALLOYS. V. N. Drobyshev and T. N. Rezukhina (Moscow State Univ.). Zh. Fiz. Khim., 39: 151-6(Jan. 1965). (In Russian)

In order to determine the thermodynamic properties of the intermediate compounds (Co_3Nb and Co_2Nb) in the system Co–Nb at elevated temperatures, measurements were made of the emf's of the cells: Pt | NbO, Nb–Co | (ThO_2–La_2O_3) | Fe, $Fe_{0.947}O$ | Pt and Pt | NbO, Nb | ThO_2–La_2O_3 | Fe, $Fe_{0.947}O$ | Pt. For the reaction $3Co + Nb \rightarrow Co_3Nb$ for the above temperature range: $\Delta G = -14,100 + 1.1\ T_{cal}$, and for the reaction $2Co + Nb \rightarrow Co_2Nb$: $\Delta G = -13,700 + 1.5\ T$, cal. An x-ray analysis of the alloys and the emf measurements confirmed the existence in the Co–Nb system of a hexagonal Laves phase of composition approaching Co_3Nb. The small difference in thermodynamic properties explained the inability of discriminating between Laves hexagonal (Co_3Nb) and cubic (Co_2Nb) phases by thermal measurements. From the emf of the second cell it was determined for the reaction $Nb + \frac{1}{2}O_2 \rightarrow NbO$ that $\Delta H^0_{298} = -99.13$ and $\Delta G^0_{298} = -92.7$ kcal, which is close to data from calorimetric measurements reported in the literature. (auth)

18527 MEASUREMENTS OF SECONDARY ELECTRON EMISSION BY KCl FOR PRIMARY ENERGIES BETWEEN 200 AND 2500 ev. E. Raquet. Thesis, Mainz, Universitat, 1963. 69p. $2.00(Gmelin, AED-DISS. 63-738). (In German)

Angular distributions of secondary electrons of KCl crystals and evaporated layers for a temperature of 250°C are given. Yields are determined by comparison with Au. Temperature dependence of yields is studied. (Gmelin Inst.)

18528 STUDIES OF THE MULTIPLE EMISSION OF SECONDARY ELECTRONS. P. Haeussler. Thesis, Mainz, Universitat, 1963. 144p. $2.00(Gmelin, AED-DISS. 63-737). (In German)

Secondary electrons were accelerated with 40 kev and focused on an anthracene scintillator. The probability distributions of the number of secondary electrons produced by one primary electron are calculated from pulse height spectra using an electronic computer. Distributions in soot, Cu–Be, Ni–Be, and NaCl are smooth and therefore in disagreement with results from Anderson and Barrington. Energy distributions were measured using a reverse field method. Results indicate that pulse height spectra can be calculated in advance assuming that all multiplicities of secondary electrons have the same energy distribution. (Gmelin Inst.)

18529 DIAGRAMMY SOSTOYANIYA METALLICHESKIKH SISTEM. OPUBLIKOVANNYE V 1962 GODU. VYPUSK VIII. (Constitution Diagrams of Metallic Systems, Published During 1962. Volume VIII). Z. M. Rogachevskaya. Moscow, Publishing House of All-Union Institute of Scientific and Technical Information, 1964. 231p.

Constitution diagrams of metallic systems compiled from data published during 1962 are presented. Descriptions are given of the method of preparation, investigation, and phase characteristics. Bibliographies are included. (R.V.J.)

18530 SPIN DENSITY MEASUREMENTS AND THE SPIN SUSCEPTIBILITY OF THE 4s-CONDUCTION ELECTRONS IN Fe. Mary Beth Stearns (Ford Motor Co., Dearborn, Mich.). 23p. (CONF-794-2)

From Magnetism Conference, Minneapolis, Nov. 1964.

It was observed that the Mössbauer spectra of many ferromagnetic alloys can be analyzed to give the effect on the internal field at an ^{57}Fe nucleus of a solute atom in any of the first six neighbor shells surrounding an Fe atom. The success of such an analysis indicates that the effects of many elements (Al, Si, Mn, V, Cr) are quite localized and in particular the results of the Al and Si alloys indicate that these atoms can be interpreted as acting like holes in the Fe lattice. From considerations of the various contributions to the hyperfine field in Fe, it appears that for the Fe–Al and Fe–Si alloy systems the observed changes can be attributed to changes in the spin polarization of the s conduction electrons as a function of distance from an Fe atom. The main features of the observed variation are: an oscillating polarization whose amplitude of oscillation is much greater than that corresponding to a Ruderman-Kittel-Kasuya-Yosida type calculation and whose sign is such as to show that the indirect exchange interactions in Fe via the 4s conduction band are strongly antiferromagnetic, and the period of the oscillation corresponds to a Fermi radius, $k_F \sim 0.95 \times 10^8$ cm^{-1}, which yields a 4s conduction electron/atom ratio of about 0.3. With the assumption of a reasonable magnetic form factor for Fe (that from neutron diffraction measurements), the observed polarization can be Fourier inverted to give the spin susceptibility of the s conduction electrons in Fe. The results of such an inversion yield a spin susceptibility function which has a large peak at the Fermi diameter. (auth)

Radiation Effects

See also CHEMISTRY — Radiation Chemistry.

Refer also to abstracts 18259, 18420, 18421, and 18451.

18531 (AERE-R-4170) ELASTIC INTERACTION ENERGY OF DISLOCATION LOOPS. A. J. E. Foreman and J. D. Eshelby (Atomic Energy Research Establishment, Harwell (England)). Nov. 1962. 20p. Dep.(mn).

The elastic interaction energy of a pair of widely spaced or infinitesimal dislocation loops is evaluated explicitly for a pair of prismatic loops. The interaction energy for a pair of like loops lying in parallel (111) planes and with the [110] Burgers vector is also derived and is found to have the same general features as for a pair of prismatic loops. For a pair of similar loops with Burgers vector inclined to the loop normal, the surfaces of constant interaction are symmetrical in a plane which bisects the angle between the Burgers vector and loop normal. The variation of the elastic interaction energy of loops with their relative orientation may be of use in understanding the behavior during annealing of neighboring vacancy or interstitial loops formed in solids as a result of irradiation damage. (auth)

18532 (AERE-R-4714) FISSION GAS EMISSION FROM UO_2 DURING IRRADIATION AT 800–1600°C. G. Jackson, D. Davies, and P. Biddle (Atomic Energy Research Establishment, Harwell (England)). Dec. 1964. 61p. Dep.; $1.80(BIS); 9s. (HMSO).

An in-pile rig for the continuous monitoring of noble gases released from uranium dioxide at high temperature is described. Two samples, of density 7.90 and 10.48 g/cm^3, were irradiated at 200°C temperature steps from 800 to 1400 and 1600°C, respectively. The release of ^{85m}Kr, ^{87}Kr, ^{88}Kr, ^{133}Xe, and ^{138}Xe was measured and that of ^{133}I and ^{135}I estimated. The release was separated into temperature-independent and temperature-dependent components and diffusion coefficients were calculated for the latter. A comparison was made with post-irradiation heating results from similar samples. The diffusion coefficients for xenon were lower than those obtained in the post-irradiation experiments. A high proportion of the 135, 133 isobars was released from the fuel as iodine. (auth)

18533 (CRFD-1174) THE LENGTH CHANGES OF ZIRCALOY-SHEATHED UO_2 FUEL ELEMENTS DURING IRRADIATION. M. J. F. Notley and A. Harvey (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1963. 36p. (AECL-1846). Dep.; $1.00(AECL).

An instrument was developed to measure the length changes of rod-type fuel elements during irradiation. The instrument, based on an air gage principle, was shown to behave satisfactorily, with a measurement stability over two months within about ±0.004 in. The measured axial expansions of two Zircaloy-sheathed UO_2 fuel elements are explicable by considering the UO_2 pellets to have a plastic core, the expansion being dictated by the thermal expansion of the innermost non-plastic ring of UO_2 or of the point of pellet to pellet contact (for a pellet with a dished end face). The temperature at which UO_2 can deform plastically depends on the stress and time of application of stress. In this experiment, plastic flow was deduced to have occurred at 750°C and probably took place at temperatures as low as 400°C at localized points of contact between pellets. (auth)

18534 (EURAEC-1318) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Quarterly Report No. 5, October 1–December 31, 1964. F. Rossi (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Jan. 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 004-63-10-TEEI(RD). 28p. (EUR-2302). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Mechanical specimen preparation and test has been continued on nonirradiated specimens and a new set of 4 melts poured. The first irradiation of Charpy V notched and tensile specimens has been done; summarized are the preliminary measurement in the RS1 reactor: neutron dose, irradiation channel temperature, iron self-shielding. A brief description of the irradiation container is also given with the irradiation conditions. A detailed description of the magnetic tests is also given: recovery of the viscosity field, magnetic measurements at room temperature on newly irradiated specimens, test magnetic measurements on dummy specimens, and viscosity field measurements after recovery. Internal friction measurements have been devoted to the cold work peak examination at about 200°C and to the characterization of some specimens to be irradiated. (auth)

18535 (FZK-188-1) MEASURED EFFECTS OF THE VARIOUS COMBINATIONS OF NUCLEAR RADIATION, VACUUM, AND CRYOTEMPERATURES ON ENGINEERING MATERIALS. VOLUME I. RADIATION-VACUUM AND RADIATION-VACUUM-CRYOTEMPERATURE TESTS. Annual Report, November 9, 1962–April 30, 1964. E. E. Kerlin and E. T. Smith (General Dynamics/Fort Worth, Tex.). May 1, 1964. Contract NAS8-2450. 553p.

A series of tests was performed to measure the combined effects of nuclear radiation and vacuum and of nuclear radiation, vacuum, and cryotemperature on a group of nonmetallic materials that are considered applicable for use in nuclear-powered space vehicles. This group consisted of materials classified as adhesives, laminates, potting compounds, electrical insulations, dielectrics, thermal insulations, and lubricants. Typical tests performed on material specimens included those sufficient to measure lap-shear strength, ultimate tensile strength, ultimate elongation, stress-strain characteristics, weight loss, lubricity, compressive strength, dissipation factor, dielectric strength, and potted-wire pull-out strength. Two vacuum systems having pumping speeds in excess of 3,100 liters/sec at 10^{-6} torr were used in these irradiations. Special dynamic-test equipment was used in conjunction with the vacuum systems to perform tests in vacuum after irradiation (without intervening interruption of the vacuum), both at room temperature and at cryotemperature. Measured properties of the materials as a function of integrated fast-neutron flux and gamma dose are reported, and recommendations for use of the various materials in applications associated with the test environments are made. (auth)

18536 (FZK-196) THE EFFECTS OF REACTOR RADIATION ON THE PHYSICAL PROPERTIES OF TWO RADIATION-RESISTANT O-RING COMPOUNDS. J. H. Lewis, P. M. Johnson, and M. R. Self (General Dynamics/Fort Worth, Tex.). Jan. 1965. 82p. (WL-TR-64-133). CFSTI.

Two O-ring compounds specially formulated for radiation resistance – PRPC 1387 (NBR) and PRPC 4387 (SBR) – were irradiated to six gamma dose levels in the range of from 4.9×10^8 to 1.5×10^{11} ergs/gm(C) at the Nuclear Aerospace Research Facility with the Ground Test Reactor. O-rings, tensile specimens, and compression-set buttons of both materials were irradiated in air at (or near) room temperature. O-rings of PRPC 1387 were also irradiated in oil. Tensile properties, hardness, compression set, weight change, and specific gravity were measured as a function of radiation dose. Several analytical procedures were used in interpreting the data. The wide range of doses employed in the experiment provides an accurate assessment of degradation produced by radiation. The highest dose resulted in complete loss of useful mechanical properties. The properties most adversely affected at lower doses were ultimate elongation, hardness, and compression set. However, both materials exhibit good radiation resistance and appear to be useful up to doses of at least 10^{10} ergs/gm(C). (auth)

18537 (NASA-TN-D-2620) EFFECTS OF 1.2 AND 0.30 Mev ELECTRONS ON THE OPTICAL TRANSMISSION PROPERTIES OF SEVERAL TRANSPARENT MATERIALS. Gilbert A. Haynes and William E. Miller (Langley Research Center, National Aeronautics and Space Administration, Langley Field, Va.). Mar. 1965. 33p. $2.00(CFSTI).

A study of the effects of 1.2- and 0.30-Mev electrons on the optical-transmission properties of several transparent materials is reported. The materials studied were synthetic annealed sapphire, synthetic fused silica, fused quartz, and other silica glasses. The spectral range examined was 0.25 to 2.7 microns. Sapphire showed little sensitivity to radiation. Synthetic fused silica also showed little sensitivity except in ultraviolet transmission; however, the effects on other silica materials varied considerably. Discoloration appeared in most of the fused quartzes and other silica glasses after irradiation. Very little degradation occurred in the infrared transmission in any of the materials. It was found that head and ultraviolet radiation have a bleaching effect on quartz damaged by radiation. (auth)

18538 (NASA-TN-D-2711) EFFECTS OF IMPURITIES ON RADIATION DAMAGE OF SILICON SOLAR CELLS. Joseph Mandelkorn, Lawrence Schwartz, Robert P. Ulman, Jacob D. Broder, Harold E. Kautz, and Richard Statler (Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio). Mar. 1965. 11p. $1.00 (CFSTI).

Study of the effects of impurities on the characteristics of solar cells led to the conclusion that the impurity deliberately added to silicon in order to lower its resistivity also plays an important role in determining radiation-damage behavior and junction characteristics of cells. Cells made from silicon doped with aluminum to a resistivity of approximately 10 ohm-centimeters have superior characteristics and maximum power output in an atomic-radiation environment. The results obtained indicate that the use of 10-ohm-centimeter aluminum-doped cells in satellite power supplies will extend the lifetimes of such supplies in a radiation environment by a factor of 25. (auth)

18539 (REIC-21(Add.)) THE EFFECT OF NUCLEAR RADIATION ON ELASTOMERIC AND PLASTIC COMPONENTS AND MATERIALS. N. J. Broadway and S. Palinchak (Radiation Effects Information Center, Battelle Memorial Inst., Columbus, Ohio). Aug. 31, 1964. 438p.

A review is presented of the state of the art of the effects of nuclear radiation on elastomeric and plastic components and materials from 1961 to the present. The mechanism of radiation damage and the effects of radiation in various environments are briefly discussed. Data summarizing the radiation-effects information on specific components and on the various types of elastomers and plastics are presented in detail. Areas in which additional work is needed are indicated. Radiation polymerization or vulcanization are not covered. The report is intended to be sufficiently inclusive to make it valuable as a reference guide relative to radiation effects under varying conditions of temperature and vacuum on elastomeric and plastic components and materials. (auth)

18540 (SC-RR-65-28) REPORT ON THE CORROSION OF IRRADIATED U – 10Mo ALLOY IN CO_2 AND N_2 AT ELEVATED TEMPERATURE. G. L. Eggert (Sandia Corp., Albuquerque, N. Mex.). Feb. 1965. Contract [AT-(29-1)-789]. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The effect of reactor irradiation on the corrosion rate of two U – Mo alloys was tested at elevated temperatures in commercially bottled CO_2 and N_2 gas. The corrosion rate in either environment increased with temperature and amount of prior hot work. Activated specimens gained weight in the test environments at a rate 3.5 times greater than unirradiated specimens. Because the corrosion products in both environments were UO_2 and U_3O_8, it was concluded that the H_2O impurity in the bottled gas was the principal corrosive agent, and that pure N_2 gas would make a suitable coolant for as-cast, unplated U^{235} – 10Mo pulsed-reactor fuel. (auth)

18541 EFFECT OF X-RAY IRRADIATION ON DELAYED PHENOMENA IN TRIGLYCINE SULFATE SINGLE CRYSTALS. T. Rewaj (Technical Univ., Szczecin, Poland). Acta Phys. Polon., 26: 1093-1100(Dec. 1964).

Measurements were made of the variations in dielectric permittivity (ϵ) accompanying the switching on and switching off of a d-c external electric field polarizing a ferroelectric sample of monocrystalline triglycine sulfate ($(NH_2CH_2COOH)_3 \cdot H_2SO_4$). The measurements were carried out both in non-irradiated samples and subsequent to irradiation with x rays of energy 50 kev during various periods of time. The maximum time of irradiation amounted to 8 hours, corresponding to a dose of about 10 MR. The effect of irradiation is apparent primarily by a shift of the maximum absolute experimentally observed variation of ϵ towards higher values of the field strength polarizing the sample. This is most probably related with immobilization of the ferroelectric domains by the defects resulting from irradiation. (auth)

18542 IRRADIATION BEHAVIOR OF TUBULAR UO_2 FUEL ELEMENTS. G. R. Cole (E. I. du Pont de Nemours and Co., Aiken, S. C.). Am. Ceram. Soc. Bull., 44: 221-5 (Mar. 1965).

Tubular fuel elements containing powdered UO_2 mechanically compacted in Zircaloy sheathing were irradiated under power reactor conditions to study the performance of this type of fuel element. The maximum exposure was greater than 13,000 Mwd/ton in tests at thermal ratings of 24 to 28 watts/cm. Columnar grain growth began and fission gas release increased sharply at 25 to 30 watts/cm, with core melting at about 60 watts/cm. Fuel elements failed from dimensional instability at 1000 to 3500 Mwd/ton in some tubes operating at thermal ratings of 40 to 70 watts/cm. (auth)

18543 EFFECT OF IRRADIATION IN A NUCLEAR REACTOR ON THE ELECTRICAL CONDUCTIVITY OF GLASSES. K. Schwabe and J. Ludenbach. Chem. Tech. [(Leipzig)], No. 1, 42(1965).

An attempt was made to increase the electrical conductivity of films of various glasses by irradiation in a nuclear reactor with a neutron flux of 10^{13} n/cm^2 sec for periods of 1, 5, 10, and 100 hr. The experiments were conducted with glasses of the following composition: Na, 21.4, Ca, 6.4, Si, 72.2 mole %; Li, 23.2, Cs, 2.0, Ba, 7.5, Si, 67.3 mole %; and Na, 23.2, Cs, 2.0, Ba, 7.5, Si, 67.3 mole %. Irradiation was found to affect the glass structure, but it did not produce the expected drop in resistivity. The resistivity of the first glass increased by 100%, that of the second glass remained unchanged,

and only the resistivity of the third glass dropped slightly. Attempts to improve the electrical conductivity of the above glasses by prolongation of irradiation and by simultaneous γ irradiation also failed. (OTS)

18544 HIGH TEMPERATURE ANNEALING OF GAMMA RADIATION DEFECTS IN N-TYPE GERMANIUM. N. A. Vitovskii, T. V. Mashovets, and S. M. Ryvkin. Fiz. Tverd. Tela, 6: 1883-92(1964).

The temperature dependence of the Hall effect was measured in samples before and after irradiation and at various stages of annealing. Sequential isothermic annealing was carried out on two series of samples containing donor concentrations (antimony) of $4 \cdot 10^{13}$ and $2 \cdot 10^{14}$ cm^{-3} respectively. Annealing was done in an oil bath at 90, 100, 120, 200, and 300°C. Each series included samples irradiated at +10°C with different doses of gamma rays from ^{60}Co. It is shown that the basic process of high-temperature annealing in samples irradiated at room temperature is bipolar annealing of the donor and acceptor components of the gamma-radiation defects. The activation energy of annealing was shown to be the same for the E_c −0.20 ev and the E_v +0.11 ev levels (1.2 ± 0.1 ev). Unipolar annealing occurs along with the bipolar process. The unipolar annealing of donors is always relatively more rapid than unipolar annealing of acceptors. Unipolar annealing of acceptors was observed only when such annealing of donors created an excessive concentration of acceptors and when the absolute rate of acceptor annealing exceeded the absolute rate of donor annealing. It is shown that, as a result of high-temperature annealing in gamma-irradiated germanium, two new levels are formed: E_c −0.13 ev and an E_v +0.22 ev. These indicate a reorganization of the radiation defect during annealing. (OTS)

18545 RADIATION EFFECTS ON SEMICONDUCTORS. Kh. Saito. Genshiryoku Kogyo, 10: No. 1, 49-53(1964). (In Japanese)

Irradiation of types n and p silicon increased its resistance because of the formation of defects in the crystalline lattice. ESR measurements showed that, at constant temperature, vacancies in the crystal lattice were unstable and diffused. Most of the vacancies were connected to impurities, atomic oxygen, and atomic phosphorus. Higher phosphorus contents may cause more E or fewer A centers since these defects may capture electrons. The electron concentration of the conductor thus gradually decreases and the resistance increases. At lower temperatures the electron concentration gradually decreases. Radiation-damage silicon cannot recover at temperatures below 100°C but only at high temperatures where the decrease in resistance is significant. Silicon heated 20 min at 160°C lost the E centers but not the A. Vacancies in the crystal lattice detached from the phosphorus atoms, combined with each other, and formed new defects. Those that did not unite broke down dislocations or separated out on the surface. In cadmium sulfide before irradiation, the photoelectric current had a peak at 510 mμ and at 600 mμ afterwards. This may be related to vacancies in the Cd or S lattice. At low temperatures after irradiation the decrease in dark current slowed down. In light-irradiated CdS the photoelectric current decreased with increasing temperature. Irradiation increased the degree of electron transfer, but recovery occurred. The concentration of current carrier increased at the moment of irradiation but decreased after heating at room temperature. (IIC-M.G.)

18546 CALCULATION OF THE NUMBER OF DISLOCATIONS PRODUCED IN CRYSTALS BY RAPID PARTICLES. A. E. Kiv and G. L. Rozentsvit (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 92-3(1964). (In Russian)

In order to improve the experimental-theoretical correlation of equations for calculating the dislocations produced in the basic crystalline structure by particles, the Kinchen-Piz equation factors representing the erosion of the energy barrier to elastic dislocation of atoms and the possibility of formation of dynamic ion clouds near energy limits were added. Manipulation of the equation necessitated substitution of approximations under certain circumstances, and assumption of both upper and lower limits for the energy of formation of dynamic ion clouds. Applying to this the energy spectra of atoms dislocated by non-relativistically charged particles led to an equation, which was discontinuous at the lower limit of erosion of the energy barrier to elastically dislocated atoms, and the upper limit of erosion of the barrier was approximately twice the lower limit. Experimentally determined discontinuity could therefore be used as a characteristic indicator for the limits of erosion of the energy barrier to elastic dislocation of atoms and formation of dynamic ion clouds. (OTS)

18547 FISSION FRAGMENT INDUCED EXPANSION IN CERAMIC MATERIALS. T. S. Elleman, R. B. Price, and D. N. Sunderman (Battelle Memorial Institute, Columbus, Ohio). J. Nucl. Mater., 15: 164-78(1965).

The fission fragment induced expansion of ceramic materials was studied by recoiling fission fragments into one face of thin, flat ceramic specimens and then using interferometry to measure the specimen deflection. Irradiation caused the specimens to become spherically curved and the fission fragment induced expansion increased in the order: $MgO < SiO_2 < BeO <$ Graphite $< Al_2O_3 < ZrO_2 <$ Pyrolytic Carbon $<$ SiC. No difference in expansion was observed for single-crystal and polycrystalline specimens. Expansion normal to the surface was measured for single crystal α-Al_2O_3 by recoiling fission fragments into a portion of the surface and then measuring the expansion step at the boundary between irradiated and unirradiated regions of the surface. The expansion was found to be independent of crystallographic orientation. Radioinduced expansion normal to the surface was at least three times the expansion in the specimen plane, indicating that fission fragment induced stresses were preferentially relieved by expansion normal to a free surface. Damage annealing during post-irradiation heating was measured and approximate values for radiation expansion coefficients and stresses in irradiated specimens were calculated. (auth)

18548 NEUTRON-EXPOSURE CORRELATION FOR RADIATION-DAMAGE STUDIES. R. E. Dahl and H. H. Yoshikawa (General Electric Co., Richland, Wash.). Nucl. Sci. Eng., 21: 312-18(Mar. 1965). (HW-SA-3378)

A neutron-exposure unit for radiation-damage studies is derived, which is proportional to gross-displacement production with little dependence on the reactor spectra or displacement model selected. The unit is applied to the analysis of irradiation-induced changes in nil-ductility temperature in steel. Data from a graphite reactor and from the core of a water-moderated test reactor were statistically distinct as originally reported. Through the application of this unit, these results could be reconciled to constitute a single body of data. (auth)

18549 DEFECTS IN IRRADIATED SILICON: ELECTRON PARAMAGNETIC RESONANCE OF THE DIVACANCY. G. D. Watkins and J. W. Corbett (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 138: A543-55(Apr. 19, 1965).

Two electron paramagnetic resonance spectra produced in silicon by 1.5-Mev electron irradiation are described. Labeled Si-G6 and Si-G7, they are identified as arising from the singly positive and singly negative charged states of the divacancy, respectively. The observed hyperfine interactions with neighboring ^{29}Si nuclei and g tensors are discussed in terms of a simple molecular-orbital treatment of the defect by the method of linear combination of atomic orbitals. In addition to the anisotropy associated with the vacancy-vacancy direction in the lattice, an additional distortion occurs which is identified as a manifestation of the Jahn-Teller effect. Thermally activated reorientation from one Jahn-Teller distortion direction to another causes motional broadening and narrowing effects upon both spectra in the temperature region 40−110°K. The motion is also studied by stress-induced alignment at lower temperatures, and the activation energy for the process is found to be ~0.06 ev for each charge state. Alignment of

the vacancy-vacancy axis direction in the lattice is also achieved by stressing at elevated temperatures. The activation energy for this reorientation process is ~1.3 ev. The magnitude and sense of the alignment in both kinds of stress experiments are consistent with the microscopic model of the defect. It is pointed out that when the divacancy reorients its vacancy-vacancy axis, it is also diffusing through the lattice. The 1.3 ev is therefore also its activation energy for diffusion. Analysis of higher temperature annealing studies allow a lower limit estimate for the binding energy of the two vacancies as ≳1.6 ev. The electric level structure is deduced, and it is concluded that the divacancy introduces one donor and two acceptor levels in the forbidden gap. (auth)

18550 PRODUCTION OF DIVACANCIES AND VACANCIES BY ELECTRON IRRADIATION OF SILICON. J. W. Corbett and G. D. Watkins (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 138: A555-60(Apr. 19, 1965).

A study is described of the dependence of the room-temperature production of divacancies and vacancies in silicon upon the energy of the bombarding electrons over the range 0.7–56 Mev. For the divacancy, the Si-G6 electron-paramagnetic-resonance spectrum associated with the singly positively charged state of the defect was monitored. As a monitor for single-vacancy production, the Si-B1 center due to the oxygen-vacancy pair was used. Over the energy range 0.7–1.5 Mev, the divacancy production rate rises a factor of 7 while the single-vacancy rate rises only a factor of 1.5, reflecting a higher threshold for divacancy production, as expected. Also presented are data on the dependence of the divacancy production rate on the orientation of the crystal axes with respect to the incident beam and on the resulting anisotropy of the divacancy orientation in the lattice. The results of the anisotropy studies are shown to be consistent with a simple microscopic model of the damage event. (auth)

18551 ON THE COLORATION OF QUARTZ CRYSTALS INDUCED BY X-RAY IRRADIATION. Toshio Katow (Keio Univ., Tokyo). Proc. Fac. Eng. Keio Univ., 16: 1-27(Aug. 1964).

A strong x-ray source was constructed to investigate the x-ray-induced coloration of quartz crystals. A large number of quartz crystals were irradiated with x rays, some of which became colored to green, gray, or brown, while others did not. The coloration was found to approach saturation with more than about 10^8R. Chemical and spectroscopic analysis revealed that quartz crystals containing relatively large amount of impurities became dark-colored on irradiation and those containing only small amount of impurities did not become colored. Artificial quartz crystals containing different amount of aluminum were synthesized, and these behaved in the same manner as natural ones on irradiation. Thermoluminescence and accompanying bleaching of colored quartz crystals were studied, from which the activation energy for the thermal bleaching of the coloration was obtained. Finally the atomic mechanism of the coloration was explained with models of the color center. (auth)

18552 EFFECT OF X-IRRADIATION ON THE ELECTRIC CONDUCTIVITY OF IONIC CRYSTALS WITH IMPURITIES. A. I. Anosov, V. I. Gutman, and Ya. N. Pershits. Uch. Zap. Pskovsk. Gos. Ped. Inst., 16: 22-6(1963).

The effects of x radiation and additive coloring on the ionic electric conductivity σ of alkali-halide crystals with foreign-ion impurities are identical. The decrease in σ is due to recombination of the impurity ions and electrons, as a result of which the foreign ions cease to participate in the conductivity. The increase in σ with increasing integral radiation dose can be attributed to the formation of additional vacancies. (OTS)

18553 THE NATURE AND ENERGY SPECTRUM OF RADIATION DEFECTS IN SEMICONDUCTORS. V. S. Vavilov. Usp. Fiz. Nauk, 84: 431-50(Nov. 1964). (In Russian)

A list is given of the recent investigations on the interaction between radiation-induced defects and the impurities or defects initially present in a semiconductor crystal, with attention to the number and distribution of the local levels contained by irradiated crystals. The information that can be deduced using various research methods (studies of structure and of photoconductivity spectra, optical studies, spin resonance techniques, combination of low-temperature irradiation with optical and electrical measurements) or using crystals with low impurity contents is briefly identified. (ATD)

18554 TRANSIENT HIGH ENERGY EFFECTS IN SEMICONDUCTORS AND INSULATORS. V. R. Honnold, C. C. Berggren, R. R. Emmert, W. M. Peffley (Hughes Fullerton, Fullerton, Calif.). 18p. (CONF-641009-10)

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

The luminescence induced in NaCl crystal, nylon, and diallylphthalate 600-01 by pulses of high-energy electrons was observed as a function of time, together with the changes induced in the electric conductivity of germanium by pulses of bremsstrahlung and high-energy electrons. A theory for the transient effects was developed. (D.C.W.)

METEOROLOGY

See *also* GEOLOGY AND MINERALOGY — Site Survey and Selection.

18555 MEASURING THE WIND IN NUCLEAR PLANTS. Claudio Gandino (C.C.R. EURATOM, Ispra, Italy). Ing. Nucl., 5: No. 2, 1-12(1964). (In Italian) (EUR-2137.i)

The wind is the most important meteorological quantity influencing the diffusion of the radioactive gas discharged from nuclear establishments. Researches on the wind are briefly discussed, and some features are indicated. Also some anemographs are described. (auth)

18556 STABLE ISOTOPES IN PRECIPITATION. W. Dansgaard (Universitet, Copenhagen). Tellus, 16: 436-68 (Nov. 1964).

The isotopic fractionation of water in some simple condensation-evaporation processes are considered quantitatively on the basis of fractionation factors. The condensation temperature is an important parameter, which has some glaciological applications. The temperature effect (the δ's decreasing with temperature) together with varying evaporation and exchange appear in the "amount effect" as high δ's in sparse rain. The relative deuterium-oxygen-18 fractionation is not quite simple. If the relative deviations from the standard water (SMOW) are called δ_D and δ_{18}, the best linear approximation is $\delta_D = 8\delta_{18}$. Some qualitative considerations are given on non-equilibrium (fast) processes. Kinetic effects have heavy bearings upon the effective fractionation factors. Such effects have only been demonstrated clearly in evaporation processes, but may also influence condensation processes. The quantity $d = \delta_D - 8\delta_{18}$ is used as an index for non-equilibrium conditions. The stable isotope data from the world wide IAEA-WMO precipitation survey are discussed. The unweighted mean annual composition of rain at tropical island stations fits the line $\delta = 4.6\delta_{18}$ indicating a first stage equilibrium condensation from vapour evaporated in non-equilibrium conditions. The stable isotope data from the world wide IAEA-WMO precipitation survey are discussed. The unweighted mean annual composition of rain at tropical island stations fits the line $\delta_D = 4.6\delta_{18}$ indicating a first stage equilibrium condensation from vapor evaporated in a non-equilibrium process. Regional characteristics appear in the weighted means. The Northern hemisphere continental stations, except African and Near East, fit the line $\delta_D = 8.0\delta_{18} + 10$ as far as the weighted means are concerned ($\delta_D = 8.1\delta_{18} + 11$ for the unweighted) corresponding to an equilibrium Rayleigh condensation from vapor, evaporated in a non-equilibrium process from SMOW. The departure from equilibrium vapor seems even higher in the rest of the investigated part of the world. At most stations the δ_D varies linearily with δ_{18} with a slope close to 8, only at two stations higher than 8, at several lower than 8 (mainly connected with relatively dry climates). Considerable variations in the isotopic composition of monthly precipitation occur at most stations. At low latitudes the amount effect accounts for the variations, whereas seasonal variation at high latitudes is ascribed to the temperature effect. Tokyo is an example of a mid latitude station influenced by both effects. Some possible hydrological applications are outlined. (auth)

PHYSICS

General

Refer also to abstracts 18911 and 19319.

18557 (AD-424952) A MODEL FOR THE PRODUCTION OF SMALL EDDIES FROM LARGE ONES IN THE PRESENCE OF A MAGNETIC FIELD. P. C. Jain (Mathematics Research Center, Univ. of Wisconsin, Madison). Sept. 1963. Contract DA-11-022-ORD-2059. 36p. (MRC-TSR-420). $3.60(CFSTI).

The process of grinding down of large eddies into smaller ones in the presence of a magnetic field in a turbulent flow is calculated. Expressions for the mean square vorticity, kinetic energy, and magnetic energy correct to third power of time have been calculated. These results have been investigated numerically. Curves have been drawn to show the behavior of mean square vorticity, kinetic energy, magnetic energy, and their ratios with time at different Reynolds numbers and for different values of the initial magnetic energy. It is found that in the initial period of the magnetohydrodynamic turbulence, there is a transfer of energy from kinetic to magnetic. The presence of the magnetic field produces a faster decrease in the mean square vorticity as compared to the case when the magnetic field is weak or absent. (auth)

18558 (ANL-6937) A STUDY OF UNSTEADY MAGNETOHYDRODYNAMIC FLOW AND HEAT TRANSFER. Ralph M. Singer (Argonne National Lab., Ill.). Nov. 1964. Contract W-31-109-eng-38. 37p. Dep.; $2.00(cy), 1(mn) CFSTI.

The unsteady, combined free and forced convective flow of an electrically conducting fluid through a transverse magnetic field is analyzed. Allowing the channel wall temperature to vary linearly with the axial coordinate of the duct allows a fully developed flow situation that linearizes the governing equations and permits an analytical solution. The unsteadiness may occur because of variations in the axial pressure gradient, wall temperature, or internal energy generation rate. The effects of the thermal and magnetic Prandtl numbers (Pr and Pr_m), the Hartmann number (M), the Rayleigh number (Ra), and internal energy generation upon the flow and heat transfer is studied. Oscillatory behavior is observed for large values of Ra and M and for Pr near unity, and the length of the transient period is found to depend strongly upon these parameters. (auth)

18559 (ANL-6940) A SPECTRAL THEORY FOR THE STATIONARY TRANSPORT OPERATOR IN SLAB GEOMETRY. Erwin H. Bareiss (Argonne National Lab., Ill.). Dec. 1964. Contract W-31-109-eng-38. 54p. Dep.; $3.00(cy), 1(mn) CFSTI.

Patterned after the operational calculus of functional analysis, a spectral theory is constructed over a general function space for stationary transport operators in plane geometry as they occur in neutron theory, radiative transfer, and other areas. As an application, the general solution of the corresponding transport equations is given in closed form. It is shown that the spectrum of the isotropic transport operator consists of the union of a discrete spectrum of exactly two points, either real or pure imaginary, and a continuous spectrum which extends from ± 1 to $\pm\infty$ of the real axis. If the discrete spectrum of the anisotropic operator consists of two points only, as is the case in practical applications, the spectrum has the same properties as in the isotropic case. Proof and additional properties of the spectrum are derived under the assumption that the scattering functions have a physically important form. (auth)

18560 (CEA-R-2608) FORMALISME LAGRANGIEN POUR UN SYSTEME DE PLUSIEURS FLUIDES EN INTERACTION ELECTROMAGNETIQUE. (Lagrange Formalism for a System of Several Fluids Interacting Electromagnetically). Michel Vuillemin (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre d'Études Nucléaires). 1964. 13p. (EUR-1915.f). Dep.(mn).

After giving the Lagrange expression for a conducting fluid in an external electromagnetic field, it is shown that a Lagrange expression can be derived for describing the evolution of the system of interacting fluids, by adding the Lagrange expression of each fluid to that of the electromagnetic field. By variation is obtained the fluid movement equation coupled to the Maxwell equations. It is shown that the study of small movements around a stationary state can be deduced from the Lagrange equation expanded to the second-power order of the perturbation. It is then possible to deduce the normal mode equations and the study of the stability by examining the modes which are marginally stable. (auth)

18561 (LA-3114) SIX-PLACE TABLES OF THE DEBYE FUNCTIONS $(E-E_0)/3RT$, $C_v/3R$, AND $S/3R$. John E. Kilpatrick and Robert H. Sherman (Los Alamos Scientific Lab., Univ. of California, N. Mex.). July 20, 1964. Contract W-7405-eng-36. 56p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Six-decimal-place tables of the three Debye functions $(E-E_0)/3RT$, $C_v/3R$, and $S/3R$, have been calculated as functions of Θ/T for the range $\Theta/T = 0(0.001)6(0.01)20-(0.1)49.9$. (auth)

18562 (LA-DC-6665) AXIAL, LAMINAR FLOW OF A NON-NEWTONIAN FLUID IN AN ANNULUS. Donald W. McEachern (Wisconsin Univ., Madison Dept. of Chemical Engineering). Sept. 25, 1964. Contract W-7405-eng-36. 49p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

The equation of motion has been solved for steady, axial, laminar, isothermal flow of an Ellis model fluid in a conduit of annular cross section. Tables are presented that may be used to obtain flow curves for annular flow of fluids whose Ellis parameters are known. The Ellis-fluid predictions are compared to experimental data on dilute polymer solutions flowing in annuli. Ellis-fluid predictions of flow curves are also compared to those predicted by the generalized-Newtonian fluid and the power-law fluid. (auth)

18563 (LADC-6300) IRREDUCIBLE REPRESENTATIONS. George A. Baker, Jr., and H. Eugene Gilbert (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1963]. Contract W-7405-eng-36. 11p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

The irreducible representations for the permutation group of n elements corresponding to a Young Tableaux of one or two rows are considered for problems dealing with electron spins. (C.E.S.)

18564 (LGI-63/25) THEORY OF COMPRESSION OF MAGNETIC FIELDS BY THIN, COLLAPSING LINERS. J. G. Linhart (Laboratorio Gas Ionizzati, Comitato Nazionale per l'Energia Nucleare, Frascati (Italy)). Dec. 1963. 18p. Dep.(mn).

An analysis is presented of the effects of liner heating and flux leakage upon magnetic-field compression experiments. It is assumed that the field is compressed by the implosive collapse of a liner that is thin with respect to the skin depth of the magnetic field diffusing into the liner. (T.F.H.)

18565 (NBS-TN-217) A BIBLIOGRAPHY OF THERMOPHYSICAL PROPERTIES OF ARGON FROM 0 TO 300°K. L. A. Hall, J. G. Hust, and A. L. Gosman (National Bureau of Standards, Boulder, Colo.). June 12, 1964. 104p. $0.55 (GPO).

A bibliography of 450 references is presented for mechanical, thermodynamic, and transport properties of argon from 0 to 300°K. Each article was reviewed and coded with regard to properties studies, type of article (i.e., experimental, theoretical, etc.), and method of presentation of the data. The temperature and pressure ranges for each property under consideration are also given. An index was

prepared according to property with 4 sub-categories: solid, liquid, gas up to 200°K, and gas above 200°K. (auth)

18566 (NP-14858) MAGNETOHYDRODYNAMIC IONIZING SHOCK WAVES. R. M. May and J. Tendys (Sydney Univ. (Australia). School of Physics). Sept. 1964. 24p. (TR-13). Dep.(mn).

The theory of magnetohydrodynamic switch-on shock waves is well understood when the electric conductivity is large ahead of the front. If this conductivity is zero, the analysis is more difficult. Kulikovskii and Lyubimov have shown in principle how the solution proceeds in this case; there are two regions in the shock front, separated by a temperature T* above which the electric resistivity is smaller than the viscosity and thermal conductivity. This general theory is applied to the switch-on ionizing shock wave, and a method for calculating T* is outlined. The shock velocity and the flow parameters behind the front are then obtained in terms of the parameters ahead of the front and the magnitude of the jump in the transverse magnetic field. (auth)

18567 (NYO-2394-14) DISLOCATION-PHONON INTERACTION. Technical Report No. 14. Tai Te Wu (Brown Univ., Providence, R. I. Div. of Engineering). Feb. 1965. Contract AT(30-1)-2394. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

In order to construct a Yukawa-like potential between edge dislocations, it is assumed that they interact through lattice vibrations. Furthermore, a mass, though very small, must be assigned to the phonons, so that the range of the field generated by an edge dislocation can be adjusted to fit experimental results. (auth)

18568 (WAPD-T-1655) TRANSIENT MAGNETOHYDRODYNAMIC DUCT FLOW. P. L. Pfennigwerth and G. Sonnemann (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1964. Contract AT(11-1)-Gen-14. 48p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Parallel flow of an electrically conducting, viscous, incompressible fluid is analyzed for parallel-plate and rectangular-duct configurations with various wall conductances. A steady, homogeneous magnetic field is applied transverse to the duct centerline and perpendicular to one pair of walls. In the specific transients treated, the initially stationary fluid is assumed to have impressed upon it an axial pressure gradient which is a function of time. The finite integral transform point of view is used to obtain a general solution in which initial and boundary conditions are introduced systematically and in a straightforward manner. Numerical results are obtained for a fluid in a square duct with all perfectly conducting walls or all perfectly insulating walls and with the fluid subject to a step pressure gradient. Graphical results are given showing the development of flow volume with time for various Hartmann numbers and showing the development of velocity and induced magnetic field with time. (auth)

18569 (AWRE-Trans-48) SHOCK WAVE FORMATION AND DISPERSION OF EXPLOSION PRODUCTS IN AIR. V. V. Adushkin. Translated by R. A. Ledward (U.K.A.E.A., Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.), from Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 5, 107-14(1963). 24p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $2.60(fs), $0.92(mf) JCL.

The laws of motion of the shock wave fronts and explosion products from explosions of TNT/RDX and PETN in air are studied by pressure apparatus, high-speed photography, and ionization probes. (T.F.H.)

18570 (ORNL-tr-460) ELECTRICAL RESEARCH LABORATORY TECHNICAL REPORT NO. 563, CHAPTERS 2-5, P.21-71. Translated for Oak Ridge National Lab., Tenn. [nd]. 74p. Dep.(mn); $7.60(fs), $2.42(mf) JCL.

For abstracts of individual chapters see: 18571, 18572, 18573, and 18574.

18571 (ORNL-tr-460(p.1-19)) MAGNETIC FIELD AND INDUCTANCE OF A HOLLOW CYLINDRICAL COIL CONTAINING A CYLINDRICAL CONDUCTOR. (Translation).

The magnetic field and inductance on the surface region of a cylindrical conductor in a hollow cylindrical coil are derived by solving Maxwell's equation exactly under the assumptions that the length of the conductor is large in comparison with that of the coil and that the wave length of the electric source is also large in comparison with the domain considered. The extension of the Nagaoka coefficient is also considered by investigating the possible modification of the coefficient, and its numerical values are tabulated. (C.E.S.)

18572 (ORNL-tr-460(p.20-36)) EDDY CURRENT LOSS AND THE MAGNETIC ENERGY ABSORBED BY THE CYLINDRICAL CONDUCTING CORE. (Translation).

It is assumed that in the exterior of the core the magnetic field is identical with that for the case of a perfect conductor and in the interior of the core the magnetic field is parallel to the surface of the core and takes the same value as that of a perfect conductor at the surface. The magnetic field on the core surface is calculated. This result is used in obtaining the eddy current loss as well as the magnetic energy absorbed by the core. A method of finding the equivalent resistance as well as inductance of a coil encircling a cylindrical core is derived, and its frequency characteristics are investigated. (C.E.S.)

18573 (ORNL-tr-460(p.37-60)) ON THE EDDY CURRENT LOSS AND THE INDUCTANCE OF A COIL WITH A CONDUCTING CORE OF FINITE LENGTH. (Translation).

An attempt is made to experimentally investigate how the apparent Nagaoka coefficient as well as the eddy current loss change with respect to the shortening of the perfectly conducting core. In order to deduce the phenomenon taking place at the core ends, the magnetic fields at the ends of the core are approximately analyzed by the method of conformal mapping for the cases with large coil and core radii. The eddy current loss that occurs at the ends is also investigated. (C.E.S.)

18574 (ORNL-tr-460(p.61-73)) CONDUCTING CORES OF HIGH PERMEABILITY MATERIALS (Translation).

An attempt is made to illustrate by several examples the measured inductance and equivalent resistance of a coil with a cylindrical iron core. The results are discussed and compared with previous results. (C.E.S.)

18575 (UCRL-Trans-1159(L)) CONSIDERATIONS ON THE CORRECTION OF 'EXPLOSIVE LENSES.' Marcello Busco. Translated by G. M. Dee (Univ. of California Lawrence Radiation Lab., Livermore), from Missili, 4: 5-12(1962). 19p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

A theoretical consideration of a number of factors which may lead to deformation of a detonation wavefront and aberrations of systems of explosive lenses is presented. Particular attention is paid to the case of the detonation velocity transient which occurs at the surface between two explosives. In certain applications, in fact, great accuracy is essential, and a thorough study of these phenomena is required to introduce the necessary corrections and to obtain the desired effects. (auth)

18576 THE ALGEBRAIC STRUCTURE OF THE TENSOR OF MATTER. Jerzy Plebanski (Instituto Politecnico Nacional, Mexico City). Acta Phys. Polon., 26: 963-1020(Nov. 1964).

The possible algebraic types of the tensor of matter are studied under the minimal assumptions that the tensor is symmetric and that the V_3 to which it is related is normal and hyperbolic. This study follows three fundamental lines: the tensor of matter is considered as a matrix; the object quadratic in that tensor with the symmetries of Weyl's tensor is considered; and the possible representations of that tensor as a superposition of three energy-momentum tensors with the algebraic structure characteristic of electrodynamics is discussed. Each line of study gives rise to specific classification of the possible algebraic types. (auth)

18577 MAGNETOGASDYNAMIC CHANNEL FLOWS. S. G. Rubin (Cornell Univ., Ithaca, N. Y.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 277-83(Feb. 1965).

The asymptotic behavior of small unsteady perturbations that are superposed on an equilibrium magnetogasdynamic channel flow is considered. Only those channels with slowly varying cross-sectional area and small characteristic width-to-length ratio are allowed, so that variations along the channel are typically much smaller than are those across the channel. Under these conditions and the provision that the current density inside the duct is small, a set of "quasi-one-dimensional" equations is obtained. From the resulting set of hyperbolic equations, the theory of characteristics provides certain compatibility relations that describe the behavior of small disturbances of the steady channel flow, which are caused by some local pressure fluctuation. Two distinct wave motions are present within the channel, and the asymptotic behaviors of both are examined with the use of the aforementioned compatibility relations. It is shown that, under certain conditions on the magnetic-field distribution, wave motions that lead to shock formation in ordinary gasdynamic flow will attenuate because of the action of the magnetic field. Therefore, an instability is no longer predicted, and the possibility of a stable or shockless flow, due to the action of a suitably placed magnetic field, is revealed. (auth)

18578 INVESTIGATION OF THE PREBREAKDOWN GAP CURRENTS BETWEEN CLEAN AND CESIUM-COATED TUNGSTEN ELECTRODES. Carol J. Bennette, R. W. Strayer, E. C. Cooper, and L. W. Swanson (Field Emission Corp., McMinnville, Ore.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 284-90(Feb. 1965).

Prebreakdown currents were measured between tungsten electrodes with varying amounts of adsorbed cesium and oxygen under both high vacuum conditions and in the presence of a cesium pressure of 2×10^{-6} torr. Under the conditions investigated, the prebreakdown currents were due to field emission from small protrusions on the cathode; the corresponding current-voltage characteristics were stable and reproducible. The main effect of surface adsorbates was to change the work function of the emitting surface. The gap voltage for a permitted gap current was thus found to be a function of surface roughness and of amount of contamination upon the electrodes and to be directly proportional to gap spacing. Typical values of the gross field for 0.1μa gap current between thermally smoothed surfaces are 3.1 Mv/cm for clean tungsten and 0.62 Mv/cm for an optimum cesium coverage. The local electric fields at the tips of protrusions on the electrodes, as determined by analysis of the resulting current-voltage characteristics, are much higher, up to 70 Mv/cm. Evidence for field and temperature induced geometrical changes of the surface is given and discussed. (auth)

18579 MAGNETIC MONOPOLES, WEAK INTERACTIONS, AND ANGULAR MOMENTUM. N. Strax. Am. J. Phys., 33: 102-4(Feb. 1965).

If magnetic monopoles were to engage in processes fully analogous to the parity nonconserving weak interaction processes engaged in by electrically charged particles, then the sign of angular momentum vectors would acquire an absolute significance. This is a consequence of the symmetry properties of electromagnetism, the symmetry properties of weak interactions, and the inequality between the numerical value of the quantum of electric charge and the numerical value of the quantum of magnetic pole strength. (auth)

18580 BALL LIGHTNING AND SELF-CONTAINING ELECTROMAGNETIC FIELDS. Philip O. Johnson (Univ. of Southern California, Los Angeles). Am. J. Phys., 33: 119-23(Feb. 1965).

A model for ball lightning is developed in which most of its energy is accounted for by a toroidal magnetic field. The poloidal motion of its electrons, which maintains the magnetic field, is stabilized by a separation of charges which produces the required electric field. Loss of electrons and ions by recombination is made up by an interaction of the magnetic field with the current which replaces the lost charges. Order of magnitude computations are made for three phenomena reported in the literature: a large ball lightning, a plasmoid observed in a submarine, and a granule on the surface of the sun. The principal justification for this model is its mechanism for extended lifetimes. (auth)

18581 A NOTE ON TIME-REVERSAL INVARIANCE. Luis J. Boya (Universidad, Barcelona). Am. J. Phys., 33: 139-40(Feb. 1965).

A simple argument is advanced, which makes it plausible that time-reversal invariance holds universally. The argument is to define the physical Lorentz group as the minimal lineal group which carries any point into any other point in a certain invariant figure, which in the physical case has two sheets. (auth)

18582 ANNUAL REVIEW OF NUCLEAR SCIENCE. VOLUME 14. Emilio Segre, Gerhart Friedlander, and H. Pierre Noyes, eds. Ann. Rev. Nucl. Sci., 14: 1-510 (1964). Palo Alto, Calif., Annual Reviews, Inc., 1964. $8.50.

Fourteen articles are included. Separate abstracts were prepared for 13. One paper was previously abstracted for NSA; see abstract 18: 30507. (M.J.T.)

For abstracts of individual papers see: 17508, 18275, 18276, 18386, 18686, 18763, 19101, 19102, 19103, 19104, 19105, 19368, and 19393.

18583 ANGULAR DISTRIBUTION OF COLLIMATED RADIATION. E. F. Fomushkin. At. Energ. (USSR), 18: 178-9(Feb. 1965). (In Russian)

Principles of probability were used for calculating the distribution of radiation. The probability method was based on the ratio of the radiation propagation event parameters (trajectory coordinates, and orbital and azimuthal angles of emission) passing through a collimator to the total number of events. The calculations were carried out with collimators with circular and rectangular cross sections. (R.V.J.)

18584 THE WAVE SURFACE IN A FLUID WITH HIGH ELECTRIC CONDUCTIVITY GENERATED BY A POLAR MAGNETIC FIELD. Tino Zeuli. Atti. Accad. Sci. Torino. I. Classe Sci. Fis., Mat. Nat., 98: 977-86(1963-64). (In Italian)

In magnetohydrodynamics, the epicentral wave surfaces relative to waves emitted in correspondence to a magnetic pole were studied. In the case of a magnetic field of weak intensity, the equations could not be determined in finite form, revealing a significant kinematic property. (tr-auth)

18585 THE FUNDAMENTAL EQUATIONS OF THE COLLISION WAVE IN MAGNETOGASDYNAMICS. Cataldo Agostinelli. Atti Accad. Sci. Torino. I. Classe Sci. Fis., Mat. Nat., 98: 987-1000(1963-64). (In Italian)

The equations of discontinuity across a shock front were deduced in the most general form for a viscous gas of finite electrical conductivity, in which the heat is propagated either by conduction or radiation. The energy of radiation and of the radiation pressure was taken into account. It is shown how, even in the general case, the component of the magnetic field normal to the shock front is continuous across the collision and that in the case in which the magnetic field is normal to the collision front the equations of jumps are reduced to those of ordinary gas dynamics. (tr-auth)

18586 BEHAVIOR OF THE DISCONTINUITY IN THE RELATIVISTIC FLUID DYNAMICS. Aldo M. Pratelli (Istituto di Matematica del Politecnico, Milan). Atti Accad. Sci. Torino. I. Classe Sci. Fis., Mat. Nat., 98: 1187-1215 (1963-64). (In Italian)

The geometric behavior of the jumps presented by the derivatives of the unknown functions in indefinite equations of a non-viscous fluid across a discontinuity hypersurface was studied, omitting the complementary equations. It may be generated by the motion of a material wave front (hypersurface position of current lines) or by the motion across the fluid of a discontinuity surface (hypersurface across current lines). This property is valid, in particular, on characteristic hypersurfaces. The differential equation of these hypersurfaces is derived in correspondence to the most general complementary equation. (tr-auth)

18587 A TYPE OF FINITE MAGNETOHYDRODYNAMIC OSCILLATIONS POSSIBLE IN A ROTATING ELLIPSOIDAL FLUID MASS WITH HIGH CONDUCTIVITY. Salvatore Rionero. Atti Accad. Sci. Torino. I. Classe Sci. Fis., Mat. Nat., 98: 1216-32(1963-64). (In Italian)

A type of finite MHD oscillations possible in a highly conducting rotating fluid mass permeated by a non-stationary field is studied in the interior of a configuration of ellipsoidal equilibrium. (tr-auth)

18588 ELECTRON MOBILITY IN A MAGNETIC FIELD. S. N. Sen and R. N. Gupta (Univ. of North Bengal, Siliguri, India). Indian J. Phys., 38: 383-7(Aug. 1964).

The values of electron mobility in air in presence of a magnetic field varying from 0 to 200 gauss and over a wide range of pressure were calculated from breakdown measurements. The validity of the expression $\mu/\mu_H = (1 + C_1H^2/P^2)$ derived by Townsend and Gill, and also by Blevin and Haydon was tested by plotting μ/μ_H against $1/P^2$; the curve is a straight line for a limited range of pressure above .125 mm of Hg. The constant C_1 is found to decrease with the increase of the magnetic field and the curve of C_1 against H is parabolic in nature. An analytical expression was derived which explains the observed variation to a first approximation. (auth)

18589 THE INFLUENCE OF MEDIUM ON THE COULOMB RELAXATION OF CURRENT CARRIERS IN SEMICONDUCTORS. V. M. Lenchenko (Inst. of Nuclear Physics, Uzbek SSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 48-53(1964). (In Russian)

The theory of deceleration of charged particles in condensed media is considered and the influence of the medium (its dielectric constant) on the relaxation of conduction electrons colliding with Cherenkov photons is estimated. It is pointed out that although the Tamm-Frank-Fermi method has recently lost ground to the method of Green's function in conjunction with diagram techniques, in most problems of practical importance the Green's function method yields solutions only in the plasma approximation, without account of the electrons bound in the atoms. It is shown that the Tamm-Frank-Fermi method can also take sufficiently accurate account of the influence of the medium on the collisions, since the accuracy of this method is limited only by the accuracy with which the dielectric constant is specified as a function of the frequency and wave vector of the photon. For thermal electrons of low temperatures, the frequency interval in which Cherenkov relaxation of the electrons occurs is small, and this relaxation is probably insignificant in ordinary media. A calculation of the relaxation time of electrons undergoing Coulomb collisions with excitation of longitudinal electromagnetic oscillations in a medium with zero longitudinal dielectric constant for longitudinal waves, yields an exact formula (without arbitrary constants) for the relaxation time of electrons in Coulomb collisions with the medium. It is shown by analysis of the results that the scattering of electrons in Coulomb fields is an appreciable factor in the relaxation of electrons in semiconductors, since the time obtained for the relaxation rate is much larger than the rate of relaxation of the electrons interacting with the lattice atomic vibrations. (ATD)

18590 IONIZATION, DIFFUSION, AND DRIFT VELOCITIES IN A PULSED TOWNSEND DISCHARGE. A. L. Ward (Harry Diamond Labs., Washington, D. C.). J. Appl. Phys., 36: 1291-4(Apr. 1965).

It is shown that an electron avalanche travels with a velocity v_- that is dependent upon Townsend's ionization coefficient α and the diffusion coefficient for the electrons D_-. Specifically, $v_- = \mu_-E + \alpha D_-$, where μ_- is the electron mobility, and the applied field E is assumed constant. Numerical machine calculations were made to study the effect of diffusion and secondary ionization at the cathode in pulsed Townsend discharges. Illustrative examples show the utility of these calculations in measurements of the Townsend ionization coefficients as well as electron and ion mobilities. It is shown that the diffusion-broadened avalanche for high values of αd (d is the gap distance) requires more than the electron transit time d/v_- to make a gap crossing. (auth)

18591 STUDY OF THE ANOMALOUS SURFACE REFLECTION OF X RAYS. O. J. Guentert (Raytheon Co., Waltham, Mass.). J. Appl. Phys., 36: 1361-6(Apr. 1965).

The anomalous surface reflection of x rays reported recently by Yoneda was investigated for several materials using $MoK\alpha_1$, $CuK\alpha_1$, and $CrK\alpha_1$ radiation. The experimental evidence speaks strongly in favor of the Warren and Clarke interpretation in terms of totally reflected small-angle scattering. For clean surfaces the scattering appears to be due to surface irregularities of the bulk material itself. Because of its sensitivity to the roughness and chemical contamination of optically or near-optically finished surfaces, the Yoneda effect has considerable promise as a new x-ray tool for studying surfaces and thin films. (auth)

18592 METHOD FOR THE DETERMINATION OF ELECTRON DRIFT VELOCITY IN GASES FROM THE CHARACTERISTICS OF HIGH-PRESSURE GAS DIODES. Lawrence V. Meisel (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Appl. Phys., 36: 1389-93(Apr. 1965).

A method was developed for determining electron drift velocities from measured current–voltage characteristics of gas-filled cylindrical diodes. Experimental data, taken in diodes filled with helium, nitrogen, and argon, are presented to illustrate the utility of the method. (auth)

18593 HIGH-FIELD MAGNETORESISTANCE OF SEMICONDUCTORS AND PLASMAS. IV. DEPENDENCE ON INCLUSION SHAPE. H. L. Frisch and J. A. Morrison (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 36: 1399-1407(Apr. 1965).

The excess dissipation due to a small spherical inclusion in a semiconductor was obtained exactly using the model of the semiconductor which was investigated previously and the four moment approximation to the electron-distribution function. The high-field limit of the transverse magnetoresistance for a dilute sprinkling of spherical inclusions, which is proportional to the high-field limit of the excess dissipation, and varies as $|\mathcal{H}|$ as $\mathcal{H} \to \infty$, where $\mathcal{H}$ is the magnetic field, was also calculated. Previously, Herring obtained approximately the excess dissipation of a cylindrical inclusion with axis parallel to the magnetic field and made plausible a high-field transverse magnetoresistance which varies as $|\mathcal{H}|/\ln|\mathcal{H}|$ as $\mathcal{H} \to \infty$. In the case of spherical inclusion, one can investigate in detail perturbations produced by the external specimen boundaries, and it is suggested that analogous results hold for a cylindrical inclusion. (auth)

18594 ALFVEN INVARIANT IN THE FIELD OF A MAGNETIC UNIPOLE. J. A. Van Allen (Univ. of Iowa, Iowa City). J. Geophys. Res., 70: 1240(Mar. 1, 1965).

It is shown that the Alfven quantity $\sin^2\alpha/B$, where α is the angle between the relativistic momentum and the magnetic vector, is a rigorous constant of the motion of an isolated charged particle in the field of a magnetic unipole. (D.C.W.)

18595 ON SEPARATION OF MAGNETIC BOUNDARY LAYER. A. Cinober, A. Shtern, and E. Shcherbinin (Inst. of Physics, Academy of Sciences, Latvian SSR). Latvijas PSR Zinatnu Akad. Vestis, No. 12, 49-56(1963). (In Russian)

By means of dissolving tin and bismuth cylinders in mercury the effect of a transverse magnetic field on the position of separation of the laminar boundary layer from the surface of a circular cylinder was measured. It is shown, that the boundary layer does not separate at Stuart numbers $M/Re \gtrsim 1$ to 2. Some theoretical considerations are discussed. (auth)

18596 LECTURES ON THE MANY-BODY PROBLEM. VOLUME 2. E. R. Caianiello, ed. Lectures Many-Body Probl., 2: 1-294(1964). New York, Academic Press, 1964. $10.50.

Fourteen papers are included. Separate abstracts were prepared for all of them. (M.J.T.)

For abstracts of individual papers see: 18597, 18598, 18599, 18600, 18601, 18602, 18931, 18932, 18933, 19026, 19027, 19028, 19029, and 19291.

18597 INTRODUCTORY REMARKS ON SOLID-STATE PHYSICS. R. E. Peierls (Oxford Univ.). Lectures Many-Body Probl., 2: 1-9(1964).

A brief review is given of typical situations in solid-state theory, and those difficult to solve except by techniques of many-body theory are identified. Consideration is given to cases of the electronic ground state of a nonconducting solid; interactions among electrons, holes, phonons, excitons, and plasmons in a semiconductor; states in a metal; and ferromagnetism. (M.J.T.)

18598 DENSITY FLUCTUATION EXCITATIONS IN MANY-PARTICLE SYSTEMS. D. Pines (Universite, Paris). Lectures Many-Body Probl., 2: 15-76(1964).

An introductory study of the excitation of quasiparticle-quasihole pairs is presented. The class of pair excitations corresponding to a density fluctuation of the system particles is considered. An inelastic particle-scattering experiment to measure elementary excitations associated with the density fluctuations is described; the results correspond to a spectral density — dynamic form factor — for the density fluctuation excitation spectrum. The dynamic form factor for fermion systems is considered, using the random phase approximation to describe collective modes of quantum and collective plasmas and of neutral fermions. The overall system response to an external probe coupled to the density fluctuations of the system particles is treated from a formal point of view. The dielectric response functions for homogeneous electron systems are also discussed. (M.J.T.)

18599 THE ELECTRON-PHONON INTERACTION IN NORMAL AND SUPERCONDUCTING METALS. Leo P. Kadanoff (Univ. of Illinois, Urbana). Lectures Many-Body Probl., 2: 77-112(1964).

The density of particles with given momentum and the self-energy — the change in the interaction energy occurring upon the addition to a system of a particle with given momentum and energy — are calculated using correlation functions and then more formally using Green functions. The equations obtained are applied to the cases of a metal and a superconductor. (M.J.T.)

18600 ELECTRONS IN DISORDERED SYSTEMS. J. L. Beeby (Univ. of Manchester, Eng.). Lectures Many-Body Probl., 2: 159-68(1964).

Behavior of electrons in systems for which the potential is not completely determined as a function of position but by some probability distribution is considered. The electron propagator in the potential is derived, and the density of states is evaluated from it, for the cases of weak potentials, polycrystalline materials, strong potentials, the Kroenig-Penney model, the tight-binding case, and a three-dimensional problem. (M.J.T.)

18601 RENORMALIZATION IN EQUILIBRIUM STATISTICAL MECHANICS. Cyrano De Dominicis (Centre d'Etudes Nucleaires, Saclay, France). Lectures Many-Body Probl., 2: 203-16(1964).

Renormalization equilibrium statistical mechanics — expressing the thermodynamical functions of a system not in terms of the bare potentials occurring in the hamiltonian but in terms of observable quantities — is considered. Normal systems are studied, reviewing the potential expression, mass renormalization and variational properties after mass renormalization, and vertex renormalization and equilibrium-parameter dependence. Superfluid systems are discussed, considering extensions of the grand canonical ensemble and renormalized formulations. (M.J.T.)

18602 CORRELATION FUNCTIONS AND MACROSCOPIC EQUATIONS. Paul C. Martin (Harvard Univ., Cambridge, Mass.). Lectures Many-Body Probl., 2: 247-85(1964).

A discussion is given of how phenomena predicted by macroscopic or hydrodynamical descriptions make their appearance in the description using time-dependent long-wavelength low-frequency correlation functions. Spin diffusion in a liquid with no spin-dependent forces is considered as an example of a simple model in which the macroscopic description is characterized by a single conservation law and phenomenological equation and in which the associated equation of state consists of a single thermodynamic derivative. The application of this kind of analysis to a normal one-component fluid is discussed, and modifications arising for a superfluid are pointed out. (M.J.T.)

18603 RELATIVISTIC (NON-LINEAR) OSCILLATOR. E. H. Hutten (Univ. of London). Nature, 205: 892(Feb. 27, 1965).

Approximate motion equations for free and driven relativistic oscillators with and without damping were studied. A red shift of the frequency was obtained, which for the driven oscillator with and without damping was essentially that of the free, undampened oscillator. The frequency shift for scattering of the light (6943 Å) from a ruby laser in a plasma was also calculated. (D.C.W.)

18604 TAPE-WOUND MAGNET COILS. R. L. Kustom and G. E. Yurka (Argonne National Lab., Ill.). Nucl. Instr. Methods, 33: 309-13(Mar. 1965).

A tape-wound coil capable of high power density and of design suitable for application to large magnets is described. The water-cooled coil of moderate size, 6 × 16 × 16 in. attained a power density of 16,900 w per pound of copper. The coil was wound with copper tapes separated by spacers to allow cooling water to pass axially through the coil. Detailed description of the conductor and fabrication is given. Discussion of maximum current density, magnet pressure, leakage currents, and monitoring is also presented. (auth)

18605 METHOD OF EFFECTIVE COUNTS FOR COMBINING EXPERIMENTAL RESULTS. F. S. Crawford, Jr. (Univ. of California, Berkeley). Nucl. Instr. Methods, 33: 332-4(Mar. 1965). (UCRL-11530)

The usual way of combining experimental data by the method of least squares gives a biased result when the errors from the individual experiments are based on Poisson fluctuations. Instead, one would like to combine the data into one large experiment. This is usually impossible because most experimenters do not publish likelihood functions. The suggested method of effective counts provides a way to treat data from several experiments as though they came from an effective single experiment when only the physical quantity and its standard deviation are published. (auth)

18606 HYDROMAGNETIC INSTABILITY OF FLUID BETWEEN TWO COAXIAL CYLINDERS. Chuen-yen Chow and Mahinder S. Uberoi (Univ. of Colorado, Boulder). Phys. Fluids, 8: 413-17(Mar. 1965).

When a uniform electric current is passed axially through a stationary fluid between two coaxial nonconducting cylinders with an electric current flowing along the axis, the fluid may become unstable due to the nonuniform electromagnetic body force field. By introducing an adjoint system of equations, the characteristic value problem is solved without the restriction of small spacing between the cylinders. Numerical results are given for the case when the ratio of the radii of the two cylinders is one-half. It shows that the wavenumber of the disturbance appearing in the fluid is a constant independent of the magnitudes of applied electric currents, which agrees with the result obtained under the narrow-gap assumption. (auth)

18607 COMPLETENESS PROPERTY OF SOLUTIONS OF THE RELAXATION PROBLEM IN KINETIC THEORY. J. H. Ferzinger (Stanford Univ., Calif.). Phys. Fluids, 8: 426-31(Mar. 1965).

It is shown that the separation of variables solution of the kinetic theory relaxation problem yields a complete set of eigenfunctions provided generalized functions are admitted as solutions. The presence of a continuum of eigenfunctions is explicitly exhibited and it is shown how the theory of singular integral equations can be utilized to give a solution of the initial value problem. (auth)

18608 STRUCTURE OF THE BOLTZMANN COLLISION OPERATOR. Leib Finkelstein (New York Univ., New York). Phys. Fluids, 8: 431-6(Mar. 1965).

The full Boltzmann collision operator with an infinite collision cross section is investigated. It is shown that in the general case the operator is bilinear in F and $\partial F/\partial \xi$ and three different representations of it are given. The linearized collision operator is further explored and a new expression for the kernel in the form of a divergence is obtained. An approximation to the linearized operator is indicated, which may prove of value in numerical calculations. (auth)

18609 ELECTRON RUN-AWAY FOR OTHER THAN COULOMB INTERACTIONS. John M. Smith (General Electric Co., King of Prussia, Penna.). Phys. Fluids, 8: 543-4(Mar. 1965).

An exact calculation (Phys. Fluids 6,1420 (1963)) of the momentum and energy exchange collision intergrals over displaced Maxwellian distribution functions possessing different mean velocities and temperatures for each species is discussed. The general results of this calculation are used to investigate the time evolution of the electron velocity in the presence of an electric field of sufficient strength to carry the velocity into the regime in which the diffusion Mach number is greater than 1. (C.E.S.)

18610 MEASURED VELOCITY PROFILES IN THE LAMINAR BOUNDARY LAYER BEHIND A SHOCK. Edmund J. Gion (Lehigh Univ., Bethlehem, Penna.). Phys. Fluids, 8: 546-7(Mar. 1965).

Velocity profiles for the laminar boundary layer in a shock tube were obtained. They are presented as a fine-scale test of the theoretical structure of the laminar shock-tube layer. The measurements were at a single shock strength in atmospheric air. Tracer particles used were oil drops of less than 1 μ diameter. (C.E.S.)

18611 THE FERMI MOMENTA OF SOME FACE CENTRED CUBIC RARE EARTH COMPOUNDS. M. I. Darby and K. N. R. Taylor (Durham Univ., Durham City, Eng.). Phys. Letters, 14: 179-80(Feb. 1, 1965).

An attempt is made to correlate the varied paramagnetic Curie temperatures of rare earth compounds with their lattice spacings using the indirect exchange theory of Ruderman, Kittel, and Yosida. It is concluded that the correlation can be made by way of the Fermi momenta of the conduction electrons. (L.B.S.)

18612 QUANTUM CORRECTIONS FOR SECOND VIRIAL COEFFICIENTS USING DIFFERENT LENNARD-JONES (m-n) POTENTIALS AND APPLICATION TO HELIUM. R. Haberlandt (Deutsche Akademie der Wissenschaften, Berlin). Phys. Letters, 14: 197-8(Feb. 1, 1965).

The second virial coefficient, its derivatives with respect to temperature, and the zero-pressure Joule-Thompson coefficient are calculated with their first three quantum corrections at 0.30 to 400°K. The results are applied to helium, and a comparison on the calculated and the experimental values is tabulated. (L.B.S.)

18613 FINITE-TEMPERATURE TRANSPORT PROPERTIES OF NORMAL FERMI SYSTEMS. I. THE GENERAL TRANSPORT EQUATION. P. Resibois (Universite Libre, Brussels). Phys. Rev., 138: B281-95(Apr. 12, 1965).

The response of a normal Fermi system to a weak external charge is expressed in terms of a one-particle Wigner distribution function which obeys a generalized transport equation valid at all temperatures. The derivation of this transport equation is closely related to the method developed by Prigogine and co-workers in nonequilibrium situations, both classical and quantum; it is based on a reclassification of the perturbation expansion of the autocorrelation formula expressing the response. The proof is greatly facilitated by the use of a suitable diagram technique which describes both the dynamical processes in the system as well as the effect of the interactions on equilibrium properties; full advantage is taken of the contraction theorem for averages over the unperturbed equilibrium ensemble. (auth)

18614 DISSOCIATIVE RECOMBINATION IN HELIUM AFTERGLOWS. E. E. Ferguson, F. C. Fehsenfeld, and A. L. Schmeltekopf (National Bureau of Standards, Boulder). Phys. Rev., 138: A381-5(Apr. 19, 1965).

Helium-afterglow experiments which have been interpreted in the literature in terms of dissociative recombination of He_2^+ cannot be so interpreted in light of recent experimental and theoretical developments. These include the quantitative theory of collisional-radiative recombination, estimates of He_2^+ vibrational relaxation times, considerations of He_2^+ (excited-state) potential curves, and rather detailed experimental results from steady-state flowing afterglow systems. (auth)

18615 ELECTRON ENERGY GAPS IN A ONE-DIMENSIONAL LIQUID. Kazuo Hiroike (Univ. of Chicago). Phys. Rev., 138: A422-8(Apr. 19, 1965).

The method of Faulkner and Korringa is applied to a one-dimensional liquid in which the atomic potentials are δ functions and the distances between neighboring atoms satisfy a Gaussian distribution. It is shown that an energy gap exists if σ, the standard deviation in the Gaussian distribution, is small enough. The behavior of the energy gaps as σ is varied agrees very well with the numerical results of Makinson and Roberts. (auth)

18616 BAND STRUCTURE OF CADMIUM SULFIDE—PHOTOEMISSION STUDIES. N. B. Kindig and W. E. Spicer (Stanford Univ., Calif.). Phys. Rev., 138: A561-76(Apr. 19, 1965).

Photoemission measurements were made at photon energies between 7.2 and 11.6 ev on single crystals of CdS which were cleaved in high vacuum at pressures $<10^{-9}$ torr. Additional measurements were made from 6 to 21.2 ev using surfaces cleaved and tested in pressures of about 10^{-4} torr. The electron affinities are found to be 4.8 ± 0.3 and 3.8 ± 0.4 ev for the high- and low-vacuum-cleaved samples, respectively. Important features of the density of states are deduced from the energy distributions. Maxima in the density of states are located in the conduction band at 6.7 ± 0.3, 8.2 ± 0.3 and (with the aid of reflectivity data) at 4.4 ± 0.5 ev. A single maximum in the valence-band density of states is found at -1.2 ± 0.3 ev and the d band of Cd is located at -9.4 ± 0.5 ev. All energies are referred to the top of the valence band. These features agree qualitatively with the calculated band structure of Herman and Skillman and, in the case of the d band, with x-ray data. Details of the density of states are deduced from the electron distributions with the aid of quantum-yield and reflectivity data by assuming that direct conservation of k is not an important selection rule and assuming constant matrix elements. The optical conductivity and quantum yield calculated from the experimentally determined density of states are in first-order agreement with the measured values. The effects of inelastic scattering due to pair production are discussed. The contribution to the energy distribution due to single pair-production events were calculated for simple models. The results agree qualitatively with the measured energy distribution. (auth)

18617 THREE-DIRECTIONAL EXPANSION OF 1/R AND δ-FUNCTION. Pei-yu Hou. Sci. Sinica (Peking), 14: 39-45(Jan. 1965).

By using integral representations of 1/R and $\delta(R)(R = r_1 + r_2 + r_3)$, it is possible to separate the angular and radial variables and to obtain an explicit expansion. (auth)

18618 ON TRANSPORT THEORY IN REAL BOLTZMANN GASES. S. Grossmann (Philipps-Universitat, Marburg, Ger.). Phys. Letters, 15: 40-1(Mar. 1, 1965).

The Boltzmann-Landau transport equation for a low-density gas is given, taking into account energy conservation in the collisional operator for the energy of a particle surrounded by the gas, group velocity, and effective force of the surrounding medium. Results of a study of this equation for a Boltzmann gas—giving modified definitions of the stress tensor, energy density, and heat flow vector—are summarized. (M.J.T.)

18619 PHASE TRANSITION IN THE HARTREE-FOCK ELECTRON GAS. S. Gartenhaus and G. Stranahan (Purdue Univ., Lafayette, Ind.). Phys. Rev. Letters, 14: 341-3 (Mar. 8, 1965).

It is shown that for moderately high densities the electron gas as described by the Hartree-Fock theory undergoes a phase transition analogous to the liquid-gas transition. The transition occurs at a density on the order of 10^{22} cm^{-3}. (D.C.W.)

18620 THE ROLE OF INVARIANCE PRINCIPLES IN NATURAL PHILOSOPHY. E. P. Wigner (Princeton Univ., N. J.). p.ix-xvi of "Dispersion Relations and Their Connection with Causality." New York, Academic Press, 1964.

The development, nature, and role of invariance and symmetry principles are reviewed. Their significance for the unification of knowledge of the inanimate world is stressed. (D.C.W.)

18621 STATISTICAL MECHANICS AND DYNAMICS. Henry Eyring, Douglas Henderson, Betsy Jones Stover, and Edward M. Eyring. New York, John Wiley and Sons Inc., 1964. 519p.

Three methods of developing statistical mechanics are presented—the classical approach of Gibbs, the Darwin-Fowler method of steepest descents, and the method of compounding an unknown with a known system. Classical mechanics, thermodynamics, classical statistical mechanics, and quantum statistical mechanics are surveyed. Discussions are given of the thermodynamic properties of crystals and of black body radiation; dielectric, diamagnetic, and paramagnetic properties of matter; electrons in solids; ferromagnetism and antiferromagnetism; real gases; equilibrium properties of liquids; liquid mixtures; dilute solutions of strong electrolytes; surface chemistry; and relaxation times. (M.J.T.)

18622 PHASE TRANSITIONS. Robert Brout. Frontiers in Physics. New York, W. A. Benjamin, Inc. 1965. 213p. $9.00.

The statistical mechanics of phase transitions, critical-region anomalies in thermodynamic and response functions, and the sets of primitive graphs for the instabilities responsible for the transitions are considered. The Ising model is described, and the phenomena of condensation, freezing, ferromagnetism (Heisenberg model and band theory), superconductivity, and Bose-Einstein condensation are discussed, using both elementary and graph-theoretical presentations. (M.J.T.)

18623 FLUCTUATION PHENOMENA IN SOLIDS. R. E. Burgess, ed. Pure and Applied Physics. A Series of Monographs and Textbooks. New York, Academic Press, 1965. 398p.

Eight articles are included on models and analytical techniques for stochastic processes, and observations, data, and interpretations of data on fluctuations. A separate abstract was prepared for one article. Chapters not abstracted are on fluctuations in magnetic and dielectric solids, theory of thermal and imperfection fluctuations in ferromagnetic solids, rotational Brownian motion, fluctuations in nonlinear systems, critical fluctuations, fluctuations due to electronic transitions and transport in solids, and fluctuations of hot electrons. (M.J.T.)

For an abstract of the individual chapter see: 19321.

18624 TABLES FOR THE ENERGY AND PHOTON DISTRIBUTION IN EQUILIBRIUM RADIATION SPECTRA. P. A. Apanasevich and V. S. Aizenshtadt. Translated by Prasenjit Basu from Tablitsy Raspredeleniya Energii i Fotonov v Spektre Ravnovesnogo Izlucheniya. A Pergamon Press Book. Mathematical Tables Series. Volume 35. New York, The Macmillan Company, 1965. 258p.

A discussion of the basic characteristics of thermal radiation from bodies in thermodynamic equilibrium is given. Tables are presented for relative energy, photon, and energy-density distributions in the equilibrium radiation spectrum on relative frequency and wavelength scales, on logarithmic scales, over finite relative frequency intervals, and on the Planck's-function frequency scale, for temperatures from 25 to 10^7°K. (M.J.T.)

18625 LECTURES ON GENERAL RELATIVITY. VOLUME I. A. Trautmann, F. A. E. Pirani, H. Bondi, G. Dixon, J. Marek, J. Hyde, P. Florides, and G. Lemmer. Brandeis Summer Inst. in Theoretical Physics. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1965. 464p.

Three articles are included on general relativity theory, gravitational radiation theory, and the Einstein equations. Separate abstracts were prepared for all 3. (M.J.T.)

For abstracts of individual papers see: 18626, 18627, and 18628.

18626 FOUNDATIONS AND CURRENT PROBLEMS OF GENERAL RELATIVITY. Andrzej Trautman (Polish Academy of Sciences, Warsaw). p.1-248 of "Lectures on General Relativity. Vol. I." Englewood Cliffs, N. J., Prentice-Hall, Inc., 1965.

A general discussion of the size of possible relativistic and quantum-mechanical effects of gravitation is given. The portions of vector and tensor algebra and differential geometry needed for the study of general relativity are developed in outline, including Minkowski space and Lorentz transformations. Various theories of space, time, and gravitation are discussed. Fundamental properties, invariance properties and conservation laws, and rigid motion in relativity theory are considered. Some formulations of cosmology are presented. (M.J.T.)

18627 INTRODUCTION TO GRAVITATIONAL RADIATION THEORY. F. A. E. Pirani (Univ. of London). p.249-373 of "Lectures on General Relativity. Vol. I." Englewood Cliffs, N. J., Prentice-Hall, Inc., 1965.

Topics in the classical theory of gravitational radiation are considered within the framework of general relativity. The role of the Riemann curvature tensor for a gravitational field is explained. The retarded field of a radiating multipole in linearized gravitation theory is examined to gain insight into the behavior of gravitational fields. The spinor formalism is developed and applied to the study of gravitational ray optics and to the analysis of exact and asymptotic solutions of the field equations. 83 references. (M.J.T.)

18628 SOME SPECIAL SOLUTIONS OF THE EINSTEIN EQUATIONS. Hermann Bondi (Univ. of London). p.375-459 of "Lectures on General Relativity. Vol. I." Englewood Cliffs, N. J., Prentice-Hall, Inc., 1965.

Foundations of special relativity and its logical development from Newton to Einstein are reviewed in an elementary fashion. The foundations of general relativity are considered, with an examination of Newtonian gravitation theory, derivation of the field equations, and discussions of singularities, negative mass, and the gravitational red shift. Gravitational waves and gravitating spheres are described. (M.J.T.)

Accelerators

Refer also to abstract 18687.

18629 (CEAL-1015) A PRECISION ENERGY CALIBRATION FOR THE CAMBRIDGE ELECTRON ACCELERATOR. Herman Winick (Cambridge Electron Accelerator, Mass.). Mar. 1, 1965. Contract AT(30-1)-2076. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The external electron beam of the C.E.A. was focused vertically and bent upward by a six-foot deflecting magnet. The deflected and undeflected beams were allowed to drift 20 feet through a vacuum pipe producing a separation of about 32". Accurate measurements of this separation were made by surveying the spots produced by the beams on glass slides. Combining this measurement of angular deflection with a precise mapping of the field of the deflecting magnet yielded a calibration of the energy of the synchrotron at nominal energies of 1, 2, 3, 4, 5, and 6 Bev. These measurements show that the peak synchrotron energy is linear with peak synchrotron magnet current. Expressed in terms of the synchrotron magnet d-c current (in terms of millivolts on the shunt), the result 62.73 Mv per Bev was obtained. This result is accurate to better than ±0.2%. It was found that careful control of hysteresis

and eddy current effects in the deflecting magnet were essential in obtaining reproducible magnetic field plots. Soon after the electron beam was first extracted from the synchrotron, and initial measurements showed that the emittance and energy spread were both small, (less than 1 cm-mRad horizontally and less than 0.3 cm-mRad vertically), a precision energy measurement was made at nominal energies of 1, 2, 3, 4, 5, and 6 Bev, using magnetic-deflection methods. (auth)

18630 (CERN-64-48) SOME WIDE-BAND QUARTER WAVELENGTH LINE COUPLING CIRCUITS. A. Susini (European Organization for Nuclear Research, Geneva (Switzerland)). Nov. 20, 1964. 75p. Dep.(mn).

The design of circuits for connecting the final power tube to the resonator in r-f acceleration systems for cyclotrons is considered. Beam loading, internal losses in the resonator and transmission line, and feedback in the power tube are ignored. (T.F.H.)

18631 (JINR-P-1853) UVELICHENIE TOKA VNUTRENNEGO PUCHKA SINKHROTSUKLOTRONA OIYaI VVEDENIEM DOPOLNITELNOI. (An Increase of the Internal Beam Current from JINR Synchrocyclotron by Additional Electrostatic Focusing). V. I. Danilov, I. B. Enchevich, B. N. Marchenko, E. A. Polferov, A. N. Safonov, and A. V. Shestov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1964. 24p. Dep(mn).

The effects produced on the accelerated proton current by the electrostatic field in the central region of the JINR synchrocyclotron are described. The electrostatic field formed by a system of electrodes situated against the dee partially compensated the defocusing action of the spatial charge of the ion bunch near the center of the synchrocyclotron. As a result, the proton current at the finite radius increased from 1.1 to 1.2 μA up to 2.1 to 2.3 μA. (auth)

18632 (JINR-P-1936) MODELIROVANIE INZHEKTSII POLYARIZOVANNYKH PROTONOV V USKORITELI TSIKLOTRONNOGO TIPA. (A Simulation of the Polarized Proton Injection into Accelerators of a Cyclotron Type). Yu. A. Plis, L. M. Soroko, and N. A. Toropkov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1964. 15p. Dep(mn).

Polarized-proton injection into cyclotrons by the neutralization method is considered. The conditions of the beam polarization degree have geen determined. Experimental data making it possible to estimate the injection efficiency, which amounts to 2.8×10^{-4} for the synchrocyclotron of the Laboratory of Nucleon Problems, have been obtained. The method is comparable to the axial injection of deuterons. (auth)

18633 (NIRL/R/74) THE DESIGN OF PEAKING STRIPS FOR NIMROD. P. F. Jones (Rutherford High Energy Lab., National Inst. for Research in Nuclear Science, Chilton (England)). Aug. 1964. Dep.(mn) $1.00(BIS); 5s. (HMSO)

The devices described give a trigger pulse when a precisely determined magnetic field has been reached. Their mechanical construction and the design of the associated electronic equipment are discussed. The precautions necessary for use in a high vacuum and the measures taken to obtain a long term stability of $\pm 0.01\%$ are described. (auth)

18634 (NP-14614) PULSATION PAR MODULATION DE VITESSE D'UN FAISCEAU DE DEUTONS DE 150 kev (these). (Pulsation by Velocity Modulation of a Beam of Deuterons of 150 kev (thesis)). Michel Bethery (Paris Univ. (France). Faculté des Sciences). [nd]. 49p. Dep. (mn).

A fast pulsation apparatus on the 600-kev SAMES accelerator was studied with the purpose of measuring neutron energy by time of flight. The apparatus makes possible the measurement of differential cross sections at 2.5 and 14 Mev. In order to obtain sufficient time resolution, neutron bursts of a duration of the order of 1 nsec were necessary. The beam chopper and bunching tube used to obtain this time resolution are described. The h-f feed of the bunching tube is discussed. The performance studies showed that for a time-of-flight base of 1 m and a pulse length of 2 nsec, the resolution can be determined as a function of energy and varies 5% at 2.5 Mev and 20% at 14 Mev. (J.S.R.)

18635 (UCRL-12215-T) COMPUTER PROGRAM FOR A HIGH-CURRENT ELECTRON ACCELERATOR. R. M. Bevensee (Lawrence Radiation Lab., Univ. of California, Livermore). [1964]. Contract W-7405-eng-48. 11p. (CONF-650306-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

A comprehensive computer program for a high-current accelerator operating in the 100 ampere/10 Mev range has been developed. The accelerator is a narrow-bandwidth, coupled-cavity device with or without feedback between input and output cavities. Equations for the transient behavior of both the pumped or buildup phase and the accelerator phase have been programmed to allow for a wide range of design parameters such as number of cavities, cavity-cavity coupling, beam-cavity coupling, cavity loss or Q, stagger-tuned cavities, input-output cavity coupling, and injected current as a function of time. The sinusoidal electric field in each cavity is expanded with the resonant modes, excited by the beam and boundary-matching magnetic current on the center holes. The irrotational field is computed as the unretarded Coulomb field of the beam as a collection of discs and their images. Feedback and feedforward waves in a waveguide that couples input and output cavities are represented by cutoff and propagating waveguide modes decomposed into Fourier components. Some computational properties of the program are discussed. (auth)

18636 THE 600 Kev COCKCROFT-WALTON ACCELERATOR FOR ELECTRON BEAM IRRADIATION. Shigeru Suematsu and Hideo Kawashima (Hitachi Ltd., Tokyo). Hitachi Hyoron, 45: No. 10, 11-16(Oct. 1963). (In Japanese)

The 600-kev Cockcroft-Walton accelerator made by Hitachi, Ltd. and installed at the Hitachi Kasei Co., Ltd., is described. The electron beam from this accelerator is used to irradiate polyethylene films to make them thermally stable and solvent-resistive. The selenium rectifiers and 0.05 μF capacitors form the three-stage Cockcroft-Walton circuit. The frequency of the power is 1 kc. The maximum accelerating voltage is 600 kv and a maximum current of 5 mamp is available. To compensate for unwanted stray capacitance, an inductor is connected in parallel with it. The pierce-type electron gun injects electrons into the 20-stage accelerating tube. (Nucl. Sci. Abstr. Japan, 3: (Sept. 1964))

18637 DOSE MEASUREMENTS AT THE ELECTRON ACCELERATOR FACILITY AT RISO. Gunnar Thaarup (Danish Atomic Energy Commission, Riso, Denmark). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138(1963), 21-8 (1964).

The beam parameters of the Risö electron accelerator and polyvinyl chloride film dosimetry used for industrial irradiations are described. After irradiation the polyvinyl chloride films were heat-treated to stabilize the radioinduced coloration and spectrophotometric measurements were carried out. Dose distributions in water and aluminum at different electron energies were determined. The choice of 10-Mev electron energy proved satisfactory; no activation problems were encountered. (M.C.G.)

18638 THE ELECTRON LINEAR ACCELERATOR FACILITY AT RISO. Niels W. Holm (Danish Atomic Energy Commission, Riso, Denmark). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138(1963), 41-5(1964).

Design and operation of the 10-Mev Electron Linear Accelerator at Risö are described. The conveyor, survey, and safety systems for irradiation of materials using this accelerator are discussed. The work program is outlined. (M.C.G.)

18639 A DUOPLASMATRON ION SOURCE ESPECIALLY FOR USE IN PRESSURE-TYPE VAN DE GRAAFF ACCELERATORS. M. von Ardenne, S. Schiller, U. Heisig, and G. Beister (Forschungsinstitut Manfred von Ardenne, Dresden). Kernenergie, 7: 811-18(Dec. 1964). (In German).

A modified duoplasmatron ion source is described, which is especially suited for use in Van de Graaff accelerators with low ion currents. Technical features of the new source are: air cooling, metal gaskets, ions pre-accelerated to about 100 v, and LaB_6 cathode. Using a diaphragm diameter of 0.14 mm, the hydrogen ion currents are 90 μ amp, of 0.65 mm the currents amount to 6 mamp, and of 0.8 mm the argon ion currents are 2.5 mamp. (auth)

18640 A SIMPLE NON-INTERRUPTING METHOD OF MEASURING PULSED ELECTRON BEAM CURRENT IN LOW ENERGY ELECTRON LINAC. P. Subrahmanyam and P. Ammiraju (Tata Inst. of Fundamental Research, Bombay). Nucl. Instr. Methods, 33: 343-4(Mar. 1965).

Equipment for an absolute current measurement and current monitoring in a low energy electron linac are described. The absolute measurements are made with a Faraday cage and a d-c micro-volt-ammeter. A brass sheet inside the chamber is used as a current monitor. The operation of the equipment is discussed. (C.E.S.)

18641 LONGITUDINAL RESISTIVE INSTABILITIES OF INTENSE COASTING BEAMS IN PARTICLE ACCELERATORS. V. Kelvin Neil and Andrew M. Sessler (Univ. of California, Livermore and Univ. of California, Berkeley). Rev. Sci. Instr., 36: 429-36(Apr. 1965). (UCRL-11089(Rev.))

The effect of finite resistance in the vacuum-tank walls on the longitudinal stability of an intense beam of particles in an accelerator is investigated theoretically. It is shown that even if the particle frequency is an increasing function of particle energy, the wall resistance can render the beam unstable against longitudinal bunching. In the absence of frequency spread in the unperturbed beam, the instability occurs with a growth rate that is proportional to $(N/\sigma)^{\frac{1}{2}}$, where N is the number of particles in the beam and σ is the conductivity of the surface material. By means of the Vlasov equation a criterion for beam stability is obtained. In the limit of highly conducting walls the criterion involves the frequency spread in the unperturbed beam, the number of particles N, the beam energy, geometrical properties of the accelerator, but not the conductivity σ. A numerical example presented indicates that certain observations of beam behavior in the MURA 40 Mev electron accelerator may be related to the phenomenon investigated. (auth)

18642 TRANSVERSE RESISTIVE INSTABILITIES OF INTENSE COASTING BEAMS IN PARTICLE ACCELERATORS. L. Jackson Laslett, V. Kelvin Neil, and Andrew M. Sessler (Univ. of California, Berkeley and Univ. of California, Livermore). Rev. Sci. Instr., 36: 436-48 (Apr. 1965). (UCRL-11090(Rev.1))

The transverse electromagnetic interaction of an intense azimuthally uniform beam of particles with itself, including the effect of a resistive vacuum tank, is investigated theoretically. It is shown that a beam of particles all having velocity v is unstable against the development of transverse waves having a phase velocity close to $(1 - \nu/n)v$, where ν is the number of transverse free betatron oscillations occurring in one revolution and n is a positive integer greater than ν. The growth rate for the instability is proportional to $N/\sigma^{\frac{1}{2}}$, where N is the number of particles in the beam and σ is the conductivity of the surface material of the vacuum tank. Stabilizing mechanisms are examined by means of the Vlasov equation and it is shown that a spread in the quantity $(n - \nu)v$, evaluated for particles in the unperturbed beam, will prevent the instability. A criterion for the spread required is shown, in the limit of walls of high conductivity, to depend upon the beam intensity and energy as well as upon certain geometrical properties of the accelerator, but not upon the conductivity. Numerical examples covering a range of particle accelerators are presented, and suggest that the theory is in agreement with the coherent beam behavior recently observed in a number of accelerators. (auth)

18643 PROPERTIES OF INCLINED-FIELD ACCELERATION TUBES. K. H. Purser, A. Galejs, P. H. Rose, R. J. Van de Graaff, and A. B. Wittkower (High Voltage Engineering Corp., Burlington, Mass.). Rev. Sci. Instr., 36: 453-7(Apr. 1965).

The avoidance of the total-voltage effect in acceleration tubes, by the use of plane electrodes with their normal inclined to the tube axis, is described. This inclined-field structure serves to sweep nonbeam charged particles out of the acceleration region soon after their formation and to reduce the probability of regenerative multiplication. A summary is presented of experiments which illustrate the major properties of this type of tube. (auth)

18644 COSMOTRON FILTERED FLAT-TOP SYSTEM. A. V. Feltman and J. G. Cottingham (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr., 36: 540-4(Apr. 1965). (BNL-8320)

A method has been developed to allow the cosmotron to produce monoenergetic external beams of $\frac{1}{4}$ sec duration by maintaining the magnet current constant (flat-top) and filtering the magnet voltage. (auth)

18645 WATER VAPOR JET TARGET FOR THE CHARGE CHANGING OF FAST ION BEAMS. M. Roos, P. H. Rose, A. B. Wittkower, N. B. Brooks, and R. P. Bastide (High Voltage Engineering Corp., Burlington, Mass.). Rev. Sci. Instr., 36: 544-6(Apr. 1965).

A water vapor jet was used in the terminal of a tandem Van de Graaff accelerator as a stripping medium. The design of this jet system, which passed a beam 2.6 cm in diameter, is described. When used experimentally, the jet converted negative ions into positive ions with an efficiency >90% and a maximum proton current of 180 μamp was measured at a beam energy of 2 Mev. This jet was also used for the production of negative ions at low energies and the equilibrium fractions for a hydrogen ion beam in water vapor are listed. (auth)

18646 NEW DESIGN FOR A PHOTON BEAM HARDENER USING SOLID LiH RODS. Brenton F. Stearns (Tufts Univ., Medford, Mass.). Rev. Sci. Instr., 36: 548 (Apr. 1965).

The use of lithium hydride as hardener to reduce the low energy population of a bremsstrahlung photon beam is discussed. A hardener design which was used at the Cambridge Electron Accelerator is described. In the hardener the lithium hydride is in the form of solid rods mounted in pairs in special holding frames. (C.E.S.)

18647 PARTICLE-OPTICAL PROPERTIES OF AN ELECTROSTATIC DEFLECTOR IN THE MAGNETIC FIELD. Rolf W. Mueller (AEG-Forschungs-Institut, Frankfort am Main). Z. Angew. Phys., 18: 342-5(1965). (In German)

The most important particle-optical properties of an electrostatic deflector, which also rotates the particle pulse in a direction perpendicular to the direction of the field lines, were calculated on an analog computer. (tr-auth)

18648 PARTICLE ACCELERATOR. Erich Blauth, Friedbert Melzner, and Erwin Meyer (to Institut fur Plasmaphysik GmbH). German Patent 1,181,837. Nov. 19, 1964. Filed Dec. 22, 1961.

A compact, easily transportable particle accelerator is described, which is especially suited for lecturing purposes. The accelerator consists of a "Palletron" voltage generator with a parabolic voltage distribution. One end flange (electron collector) of the Palletron is substituted by a pierced electrode to let through the particles escaping the parabolic voltage configuration. Additional electrodes are arranged near the pierced electrode and are charged in such a way that the voltage parabola of the Palletron is continued by a parabolic voltage branch having an opposite voltage gradient to the neighboring branch in the Palletron. The additional electrodes are for acceleration of the escaping particle onto a target. (Gmelin Inst.)

18649 LONG STRAIGHT SECTIONS FOR ALTERNATING GRADIENT SYNCHROTRONS. T. L. Collins (to U. S. Atomic Energy Commission). U. S. Patent 3,171,025. Feb. 23, 1965.

A charged particle focusing system, comprising spaced quadrupole magnets, for strongly focusing the particles in

a circulating beam to facilitate circulation of the particles in long magnet-free sections between the quadrupole magnets is described. This system has an advantage of permitting increased efficiency and ease of use of the individual straight sections for injection, extraction, acceleration, beam side tracks, etc. Provision is made for storage rings and accelerator rings of decreased size and cost. Also provided are means of reacting a target relatively against the beam for separation of the particles from the beam through one of the quadrupole magnets to deflect the separated particles at a sharp angle to the beam axis. (AEC)

Astrophysics and Cosmology

Refer also to abstracts 18387, 18626, 18951, 18970, 18973, 18990, 19010, 19014, 19015, and 19266.

18650 COSMOLOGY AND NEWTONIAN MECHANICS. C. Callan, R. H. Dicke, and P. J. E. Peebles (Princeton Univ., N. J.). Am. J. Phys., 33: 105-8(Feb. 1965).

It is shown that Newtonian mechanics is quite sufficient to discuss the dynamics of the expanding universe. A completely correct discussion is presented of the dynamics of the expansion in a region where both general relativity and Newtonian mechanics are equally valid. (auth)

18651 MODEL ATMOSPHERES AND LINE PROFILES FOR EARLY-TYPE STARS. Dimitri Mihalas (Carnegie Institution of Washington, D. C. and California Inst. of Tech., Pasadena). Astrophys. J., Suppl. Ser., 9: 321-437 (Jan. 1965).

Model atmospheres were constructed over a wide range of temperature and gravities. The condition of radiative equilibrium is enforced, using a modification of the temperature correction scheme devised by Avrett and Krook, thus extending the work of Gingerich to the realm of higher temperatures; flux constancy is attained to within ±0.5% to a depth of $\tau_{STD} = 10$ or more, the standard wavelength being either 4000 or 5050 Å. The source function is determined from the Milne-Eddington equation allowing for coherent scattering in the continuum. The properties of the atmospheres are described and given in detailed tabular form, and data of rather general use is presented. For each model Hβ and Hγ profiles and equivalent widths were calculated, and for the hotter models, profiles and equivalent widths of λ = 4686, 4200, 4542, 5412 Å of He II, and λ = 5876, 4713, 4438 and 4121 Å of He I were calculated. When necessary, allowance was made in the computation of the hydrogen-line profiles for the overlapping Pickering-series lines of He II. Complete profiles are given for the hydrogen lines because of their great practical utility, but only equivalent widths are tabulated for the helium lines. (auth)

18652 EFFECTS OF BOUND-BOUND ABSORPTION ON STELLAR OPACITIES. Arthur N. Cox, John N. Stewart, and Donald D. Eilers (Los Alamos Scientific Lab., N. Mex.). Astrophys. J., Suppl. Ser., 11: 1-21(Jan. 1965). (LADC-5156)

Opacities and monochromatic absorption coefficients, including the effects of line absorption, are given for a mixture of astrophysical interest at 111 temperature-density points. The methods used for the calculations are described, and the results are compared with previously published continuous opacities. (auth)

18653 RADIATIVE AND CONDUCTIVE OPACITIES FOR ELEVEN ASTROPHYSICAL MIXTURES. Arthur N. Cox and John N. Stewart (Los Alamos Scientific Lab., N. Mex.). Astrophys. J., Suppl. Ser., 11: 22-46(Jan. 1965). (LADC-4080)

Radiative and conductive opacities including the effects of bound-bound absorptions are given in detail for eleven mixtures. All important absorption and scattering processes known are included, except the recently discovered free-free absorptions by electrons in the field of the H_2 molecule. A discussion on interpolation between mixtures of different composition is included. (auth)

18654 THE ATMOSPHERES OF THE METALLIC-LINE STARS IN THE HYADES. Peter S. Conti (Univ. of California, Berkeley). Astrophys. J., Suppl. Ser., 11: 47-94(Jan. 1965).

A spectrophotometric study of five metallic-line stars in the Hyades star cluster is undertaken to determine the abundances of elements with respect to a normal star of the cluster, 45 Tauri. The equivalent widths of over 400 lines in the wavelength range from 3900 to 6800 Å are used. Effective temperatures are derived from photoelectric six-color observations. Model atmospheres with these temperatures, and with gravities derived from a mass-luminosity relation, are constructed by using a scaled solar T (τ) and extensive opacity tables. The exact state of ionization of each ion is determined from the model atmosphere, and a weak-line approximation is used to determine the predicted shift in a curve of growth. Abundances are derived by a comparison between this and the observed line strengths. Several types of model atmospheres are investigated: normal dwarfs; those of effective gravity decreasing outward through the atmosphere; those of a higher boundary temperature than a scaled solar T (τ); and those of 80% helium abundance. It is concluded that none of these models or combinations of them can explain the well-known observed deficiencies of calcium in metallic-line stars in terms of atmospheric structure. Models with a slightly lower effective gravity in the atmosphere than that obtained from a mass-luminosity relation fit somewhat better the observed neutral-ionized line strengths. It is possible that iron is overabundant by a factor of 2 or 3 in the hotter metallic-line stars. Some elements lighter than the iron-peak elements are underabundant with respect to iron and heavier elements overabundant. (auth)

18655 NUCLEOSYNTHESIS OF HEAVY ELEMENTS BY NEUTRON CAPTURE. Philip A. Seeger (California Inst. of Tech., Pasadena), William A Fowler, and Donald D. Clayton. Astrophys. J., Suppl., Ser., 11: 121-66(Feb. 1965).

Nucleosynthesis of elements heavier than the iron group by neutron capture on both slow and fast time scales is evaluated. The s-process calculations of Clayton, Fowler, Hull, and Zimmerman were revised to include more recent experimental results on abundances and neutron capture cross sections. The solar system s-process abundances indicate a history of neutron exposure distributions characterized by decreasing probability of high integrated flux; an exponential exposure distribution is extracted. Estimates are made of the s-process contribution to each isotopic abundance; a table gives the amounts of elements produced by each process in the solar-system material. The r-process calculations are carried out using a semi-empirical atomic mass law to determine neutron binding energies and beta-decay probabilities. The solar-system r-process material was probably synthesized in two distinct types of environments, one of about 4 sec duration with temperature $\sim 2.4 \times 10^9$°K and neutron density $\sim 5 \times 10^{26}$ cm^{-3}, and the other of the same or longer duration with temperature $\sim 1.0 \times 10^9$°K and neutron density $\sim 3 \times 10^{25}$ cm^{-3}. Both of these environments could be found in an object with mass $\sim 10^5$ $M_\odot$. (auth)

18656 THE SPEED AND ACCELERATION OF THE SOURCES OF TYPE III AND TYPE V SOLAR RADIO BURSTS OVER LARGE DISTANCES IN THE CORONA. R. T. Stewart (Commonwealth Scientific and Industrial Research Organization, Chippendale, New South Wales, Australia). Australian J. Phys., 18: 67-76(Feb. 1965).

The outward velocity and acceleration through the solar corona of the disturbances responsible for the emission of 50 type III bursts recorded on the Dapto radio spectrograph are investigated by applying standard electron density models for the corona to the frequency drift of each burst. If current models for an active region are assumed, the velocities often remain unchanged from the lower corona out to heights of at least two solar radii above the photosphere. The mean velocity is about 0.33c. Speeds of sources of type III bursts followed by type V continuum are similar to those for isolated type III bursts. The constancy of the outward velocity over large distances in the corona implies that the speed of the electrons which con-

stitute the disturbance may reasonably be identified with the observed speed of the source as a whole. If this conclusion is correct, the electron speeds are too low to account for type V continuum by the synchrotron hypothesis of Wild, Sheridan, and Neylan. (auth)

18657 FOUNDATIONS OF RELATIVISTIC COSMOLOGY. Jaroslav Pachner. Cesk. Casopis Fys., 15: 1-28 (1965). (In Czech)

The bases of cosmology derived from the general theory of relativity are reviewed. 96 references. (D.C.W.)

18658 STUDY OF MAGNETIC FIELDS BY ARTIFICIAL SATELLITES AND INTERPLANETARY PROBES. Vaclav Bucha. Cesk. Casopis Fys., 15: 29-41(1965). (In Czech)

The use of satellites and interplanetary probes to investigate the distribution, magnitude, and variations of the magnetic fields of planets and interplanetary space is discussed with consideration of some of the data obtained. (D.C.W.)

18659 SPECTRUM OF DISTRIBUTED COSMIC RADIOEMISSION FOR DECAMETER WAVE BAND. Yu. S. Korobkov (Gor'kii State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 982-4(1964). (In Russian)

Until recently it was assumed that the intensity of the cosmic radio emission remains constant within a broad wavelength range, while the spectral index reported by various authors varied between 0.2 and 1, even within the same range. It was found that this index depends on the frequency, but there were no data to confirm this fact in the decameter (10 to 30 m) wavelength range. Measurements were therefore carried out on cosmic radio emission in the 40 to 6.3 Mcps range during September and October, 1963. In order to minimize the effect of the ionosphere, the observations were carried out during the night when the critical frequency of the ionosphere is low. The radiation was received at 40, 25, 18.6, 13, 9, and 6.3 Mcps by means of identical, multidipole antennas. The error in the measurements varied between ±7 and ±12%, depending on the frequency. The center of the observed region was defined by the galactic coordinates l = 98.5°, b = –5.3°. The results showed that the intensity of the cosmic radio emission reaches a flat portion at about 8 to 9 Mcps, beyond which it tended to decrease. Calculations indicated that the density of the ionized gas in the plane of the galaxy is about 0.13 electrons-cm^{-3}. On the basis of the frequency dependence of the spectral index it can be expected that the temperature maximum of the radio emission lies at 2.1 Mcps. (TTT)

18660 SATURATION EFFECTS IN STELLAR ATMOSPHERIC ABSORPTION LINES. D. Mugglestone and B. F. O'Mara (Univ. of Queensland, Brisbane, Australia). Monthly Notices Roy. Astron. Soc., 129: 41-50(1965).

The influence of saturation effects upon atmospheric abundances derived from faint and medium-strong stellar absorption lines is considered. A physical interpretation is made of how saturation occurs and how the magnitude of the saturation is influenced by broadening mechanisms, atmospheric turbulence, elemental abundances, etc. The influence of saturation on the determination of the abundances of solar atmospheric nitrogen and oxygen is considered, and strong disagreement is expressed with the results found by Neven for these two elements. Saturation effects are found which lead to abundances smaller (by a factor of the order of ten for the medium-strong lines considered) than those obtained by Neven. (auth)

18661 THE TWO-COLOUR DIAGRAM AS A KEY TO PAST RATES OF STAR FORMATION AND PAST RATES OF METAL ENRICHMENT OF THE INTERSTELLAR MEDIUM. M. E. Dixon (Univ. of Cape Town). Monthly Notices Roy. Astron. Soc., 129: 51-61(1965).

The two-color diagram for main sequence stars is used to investigate past rates of metal enrichment of the interstellar medium and past rates of star formation. It is estimated that approximately two thirds of all stars, in an infinite cylinder drawn perpendicular to the galactic plane near the sun, were formed during the first few 10^8 years in the galaxy's history. Values are given for the metal abundances of the interstellar medium at the termination of the initial burst of star production and at the present epoch. The investigation further indicates that present values for the luminosity function for main sequence stars require revision. (auth)

18662 OCCULTATION OF TAURUS-A BY THE SOLAR CORONA AT 430 Mc/s IN JUNE 1964. M. R. Kundu (Cornell Univ., Ithaca, N. Y.). Nature, 205: 683-4(Feb. 13, 1965).

The radiation from Taurus A was observed at 430 Mc/sec during the occultation of Taurus A by the solar corona in June 1964. A slight increase in the angular size of the source was noted, together with a decrease in its intensity. These effects were attributed to multiple scattering of the radiation at electron density irregularities in the corona. (D.C.W.)

18663 SOFT X-RAY IMAGE OF THE SUN. P. C. Russell (Univ. of Leicester, Eng.). Nature, 205: 684-5 (Feb. 13, 1965).

A soft x-ray photograph of the sun was obtained during a period of quiet sun, using an x-ray pinhole camera carried by a rocket. The photograph was compared with CaK plage photographs and a 9.1-cm spectroheliograph. Good correlation was observed between the bright patches on the photograph and the plage and limb areas. (D.C.W.)

18664 POSSIBLE MAGNETOSPHERIC PHENOMENA ASSOCIATED WITH NEUTRON STARS. A. G. W. Cameron (Goddard Space Flight Center, New York). Nature, 205: 787(Feb. 20, 1965).

It is suggested that the discrete x-ray sources observed in space are neutron stars with an associated magnetosphere. The x-ray spectrum would have a thermal component emitted from the photosphere and a nonthermal synchrotron component emitted by trapped electrons accelerated in the magnetosphere. (D.C.W.)

18665 RELEASE OF GRAVITATIONAL ENERGY IN GENERAL RELATIVITY. E. R. Harrison (Rutherford High Energy Lab., Chilton, Berks, Eng.). Nature, 205: 788-9(Feb. 20, 1965).

The release of gravitational energy is studied, assuming that a free particle of mass m moves in from infinity and strikes the surface of a spherical body of mass M and radius R, a fraction of the particles' energy then being radiated away as a single particle (neutrino or photon) of zero mass. The effect of the infinitesimal mass m as M approaches its limiting critical radius is considered. (D.C.W.)

18666 GALACTIC FLARES AND QUASI-STELLAR RADIO SOURCES. P. A. Sturrock (Stanford Univ., Calif.). Nature, 205, 861-4(Feb. 27, 1965).

It is proposed that on a galactic scale gravitational and magnetic energy is released in flares similar to solar flares. A model for these galaxoids is outlined, and the radio source 3C273 is treated as an example. (D.C.W.)

18667 THE ENIGMATIC QUASARS. H. P. Palmer (Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.). New Scientist, 25: 16-19(Jan. 7, 1965).

The detection and identification of various quasars (stellar bodies of intense ultraviolet radiation) at distances towards the limits of the observable universe are discussed. Some theoretical problems for astrophysicists are described. (R.E.U.)

18668 THE SOLAR WIND. W. I. Axford (Cornell Univ., Ithaca, N. Y.). New Scientist, 25: 357-9(Feb. 11, 1965).

Some satellite observations and subsequent interpretations are described for the solar plasma. The explanation of phenomena such as auroral and magnetic storms, the behavior of comet tails and cosmic rays, and other galactic happenings is discussed in terms of this "solar wind". (R.E.U.)

18669 ON THE GRAVITATIONAL MASS OF ANTIPARTICLES, THE GRAVITATIONAL ENERGY SHIFT OF SPECTRAL LINES, AND THE PRINCIPLE OF EQUIVALENCE. P. Thieberger (Centro Atomico Bariloche, Argentina). Nuovo Cimento (10), 35: 688-9(Jan. 16, 1965).

It is shown that no conclusion regarding the gravitational interaction of antiparticles can be drawn from the gravitational frequency-shift experiments and the principle of conservation of energy. (C.E.S.)

18670 ARE THERE MAGNETIC FIELDS AROUND A NEUTRON STAR? D. Boccaletti, V. de Sabbata, and C. Gualdi (Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cimento (10), 36: 685-8(Mar. 16, 1965).

An attempt is made to determine if a neutron star could be responsible for a magnetic field, that is, if a neutron gas behaves, near the nuclear density under particular conditions, as a ferromagnetic substance, owing to the magnetic moment of the neutron. (C.E.S.)

18671 NEUTRON STARS. John N. Bahcall and Richard A. Wolf (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 14: 343-6(Mar. 8, 1965).

The effects of strong interactions among the hadrons in neutron stars were calculated on the basis of an independent pair model, together with the rate of cooling by neutrino emission. The cooling rates obtained are much higher than previous estimates and are inconsistent with the existence of a hot neutron star in the Crab Nebula. (D.C.W.)

18672 STUDY OF M-REGIONS DURING 1961 TO 1963. Kenji Sinno (Radio Research Labs., Nakaminato, Japan). Rept. Ionosphere Space Res. Japan, 18: 314-18(1964).

The recurrence of geomagnetic activity during the current sunspot minimum was studied in connection with solar activity. It was concluded that enhanced beams of solar corpuscular streams emerge from the outer fringe of active coronal centers with a velocity on the order of 400 to 500 km/sec. (D.C.W.)

18673 SOME PROBLEMS IN GAMMA AND X-RAY ASTRONOMY. V. L. Ginzburg and S. I. Syrovatskii. Usp. Fiz. Nauk, 84: 201-42(Oct. 1964). (In Russian)

Various mechanisms for the production of gamma rays in the galaxy and metagalaxy and the efficiency of these mechanisms are discussed. The main emphasis is on gamma rays generated by cosmic rays. The converse problem, that of obtaining information on cosmic rays from measurements of the intensity and spectrum of the metagalactic gamma rays, is also considered. A study of x-ray astronomy is made, limited to cosmic rays; the possible contribution of cosmic rays to the intensity of x rays arriving on earth from outer space is examined. The existence of low-energy particles (less than 10^8 ev) capable of producing the extraterrestrial x rays is discussed. 79 references. (ATD)

18674 RELATIVISTIC ASTROPHYSICS. PART I. Ya. B. Zeldovich and I. D. Novikov. Usp. Fiz. Nauk, 84: 377-417(Nov. 1964). (In Russian)

A study is made of the massive cosmic bodies and systems of bodies which are probably the sources of the tremendous energy stored in the cosmic rays and magnetic fields of some of the powerful radio galaxies. These objects include quasars and other objects whose dimensions and luminosities are very high, and which from theoretical considerations should be in a relativistic state. The study of the processes occurring during the stages of evolution is started with a review of general information on the equilibrium of a star and its evolution, and with conditions that bring the star into a relativistic phase. An analysis is made of the properties of a spherically symmetric gravitational field in vacuum (Schwarzschild field). Objects for which an important role is played by the Einstein gravitation theory are discussed. 73 references. (ATD)

18675 THE SOLAR CORONA. Proceedings of International Astronomical Union Symposium No. 16, held at Cloudcroft, New Mexico, 28-30 August 1961. John W. Evans, ed. New York, Academic Press, 1963. 353p.

Thirty-five papers and summaries of nine discussion groups are presented. Discussions are included of coronal heating and temperature; x-ray, visible, infrared, and short-wave emission spectra; flares, bursts, sunspots, and prominences; solar corpuscular emission. (M.J.T.)

18676 SOLAR FLARES. Henry J. Smith and Elske v. P. Smith. New York, The Macmillan Company, 1963. 332p.

A summary is given of known information on solar flares, and advances in observational techniques are outlined. Various solar phenomena are reviewed, and discussions are presented on monochromatic optical observations of flares, flare spectral characteristics, radio emission, corpuscular emission and geophysical phenomena, and the relation of flare mechanisms to stellar activity. 662 references. (M.J.T.)

Atomic Physics

Refer also to abstracts 18621 and 18746.

18677 (ANL-6959) SCF EXCITED STATES AND TRANSITION PROBABILITIES OF SOME NEON-LIKE AND ARGON-LIKE IONS. Paul S. Bagus (Argonne National Lab., Ill.). Oct. 1964. Contract W-31-109-eng-38. 80p. Dep.; $3.00(cy), 2(mn) CFSTI.

Thesis submitted to Univ. of Chicago.

Analytic self-consistent field (SCF) wave functions were computed for the ground states of the closed-shell atomic systems F^-, Ne, Na^+; and Cl^-, Ar, and K^+, and for those ground and excited states of the open-shell systems that are obtained by removing a single electron from any one of the occupied shells of these closed-shell systems. Details of the calculation of the functions are presented with emphasis on a justification of the procedures used for the calculations for excited states. A high accuracy is obtained; the calculations for the closed-shell systems give the most accurate analytic SCF wave functions that have yet been reported. Ionization potentials are calculated and compared with experimental values. Computed ionization potentials for the removal of a 2s electron from Cl^-, Ar, and K^+, for which no direct experimental data are available, are estimated to be accurate to within 1%. It is found that the removal of an electron from the outermost s shell increases the correlation energy, in contradiction to the predictions of a recently proposed semi-empirical scheme for estimating the correlation energy. For example, the magnitude of the correlation energy of the lowest ^3S state of Ar^+ is ~4 ev greater than the magnitude of the correlation energy of neutral argon. The effect of the nonzero off-diagonal Lagrangian multipliers is considered and found to be important for the inner-shell hole states. The SCF functions were used to compute dipole transition probabilities for photon emission. The transition probabilities are computed in several different ways to examine the effects of various approximations. In particular, the results obtained using length, velocity, and acceleration operators are compared. The calculated radiation width for the K-state of argon is combined with an experimental value of the K-fluorescence yield to obtain a value of the total K-state width in agreement with experiment. (auth)

18678 (BNL-7965) INTERPRETATION OF THE SOFT X-RAY EMISSION SPECTRUM OF LITHIUM METAL. Bernard Mozer (Brookhaven National Lab., Upton, N. Y.) and D. A. Goodings (Pittsburgh Univ., Pa.). [1963]. Contract [AT(30-2)-Gen-16]. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The shape of the soft x-ray emission spectrum of lithium is calculated in the Hartree-Fock approximation taking into account the fact that an atom about to emit K_β x-ray is a point defect in the otherwise periodic potential. The perturbation from the 1s hole is treated in the lowest order "strongly localized" approximation, its effect being expressed by a single parameter. Starting from Ham's calculated density-of-states function and gradually increasing the strength of the perturbation, one observes the formation of a resonance state (virtual bound state) and then a real bound state. For reasonable values of the perturbation parameter the results show a peak about 1 ev

below the Fermi energy, in agreement with experiment. (auth)

18679 (BNL-8889) REPULSIVE ATOM-ATOM INTERACTIONS. Cavid Erginsoy (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 30p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The interaction of atoms and molecules at separations smaller than "atomic" dimensions is mainly repulsive. By analyzing the total energy of interaction into its kinetic and potential components, it is seen how repulsive forces can arise from the increase of the average kinetic energy of the electrons. Various standard forms of interatomic potential energy were analyzed in this manner. The definition of an interatomic potential relies very heavily on the possibility of separating nuclear and electronic motion. The original Born-Oppenheimer and the later Born versions of the approximation (the adiabatic approximation) that allows such a separation to be made are discussed. Simple criteria and models of non-adiabatic transitions were described, and difficulties in estimating quantitatively the rather high observed ionization and excitation cross sections were stressed. Relations between the interatomic potentials and various measureable quantities (in both the gas and solid-state phases) were discussed. Detailed information on the potential is provided in specific experiments designed for this purpose. Discrepancies exist between the calculated and experimentally determined potentials for the relatively simple and theoretically tractable He-He system, which have been attributed to possible non-adiabatic effects. No conclusions can be reached at the moment from available theoretical calculations. Further precise experiments can supply valuable information on the limitations of the adiabatic description of quasi-elastic collisions. (auth)

18680 (IMP-AEC-34) TRANSPORT PROPERTIES OF GASEOUS He^3 AND He^4. L. Monchick, E. A. Mason, R. J. Munn, and Francis J. Smith (Institute for Molecular Physics, Univ. of Maryland, College Park). Mar. 1, 1965. Contract [AT(40-1)-2058]. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A complete quantum phase shift calculation of several transport coefficients of gaseous ^3He, ^4He, and $^3He-^4He$ mixtures has been carried out from 0.2 to 300°K for a Lennard-Jones (12–6) potential model. Emphasis was placed on those properties for which experimental data were available, such as the viscosity of ^4He, the thermal conductivity of ^3He and ^4He, the spin diffusion of ^3He, and ordinary diffusion and thermal diffusion of $^3He-^4He$ mixtures. (auth)

18681 (IS-1107) LOCALIZED SELF-CONSISTENT FIELD ORBITALS IN ATOMS AND MOLECULES. Klaus Ruedenberg (Ames Lab., Iowa State Univ. of Science and Tech.). Feb. 23, 1965. Contract W-7405-eng-82. 22p. (CONF-650208-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Symposium for Quantum Chemistry, Istanbul.

It is supposed that the electronic wavefunctions of molecular systems contain certain common features, and an attempt is made to cast the wavefunctions into forms that put these regularities in evidence. The regularities are contained in the density operator and the pair-density operator. Arbitrariness of Hartree-Fock orbitals, fixation of Hartree-Fock orbitals, canonical SCF orbitals, externally localized SCF orbitals, intrinsically localized SCF orbitals, localized orbitals and molecular symmetry, and localized orbitals in the absence of symmetry are discussed. (C.E.S.)

18682 (NASA-TN-D-2659) ELECTRON-BREMSSTRAHLUNG DIFFERENTIAL CROSS SECTIONS FOR THIN AND THICK TARGETS. W. Wayne Scott (Langley Research Center, National Aeronautics and Space Administration, Langley Station, Va.). Mar. 1965. 58p. $3.00(CFSTI).

Thin- and thick-target bremsstrahlung spectra are presented for electron energies up to 7.0 Mev. The thin-target results were determined from bremsstrahlung differential cross section relations, whereas the thick-target spectra were evaluated by assuming that the total emission spectrum from a thick target is a summation over each of the spectra from a series of thin targets, one behind the other, with the energy of the incident electron decreasing for each succeeding thin target. Photon attenuation within the target has been considered. The procedure for computing the thin-target relations has been programmed in FORTRAN II for the IBM 7094 electronic data processing system. (auth)

18683 (NP-14859) EXCITATION OF H ATOMS BY PROTON IMPACT AND BY FAST ATOM IMPACT. Robert M. May (Sydney Univ. (Australia). School of Physics). Jan. 1965. 8p. (TR-15). Dep.(mn).

Expressions are derived for the cross sections for excitation of hydrogen atoms by proton and fast atom impact. Results are tabulated for proton energies from 1.6 to 200 kev and hydrogen atom energies from 1.6 to 100 kev. (C.E.S.)

18684 (TID-21565) IONIZATION AND CHARGE TRANSFER CROSS SECTIONS. Technical Status Report No. 17. Progress Report, December 1, 1963–November 30, 1964. D. W. Martin, E. W. Thomas, L. J. Puckett, and G. O. Taylor (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Dec. 1, 1964. Contract AT(40-1)-2591. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Equipment and methods used to measure the total apparent cross sections for production of slow positive ions and free electrons by reactions of doubly charged He ions at 0.18 to 1.0 Mev with N_2 and Ar are reported. Efforts to reduce the background in the collision chamber, resulting in gage readings of 10^{-7} torr, are described. Investigations of problems concerned with excess electron currents in the collector and collimator are discussed. Design and development of an analyzer for slow ions are also discussed. (J.R.D.)

18685 ION BEAM NEUTRAL COMPONENT DETERMINATION BY RESONANCE RADIATION ABSORPTION. Robert K. Cole, David F. Hall, Robert F. Kemp, and J. M. Sellen, Jr. (TRW Space Tech. Labs., Redondo Beach, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 263-9(Feb. 1965).

The presence of un-ionized propellant efflux from an ion thrustor may be detected by its absorption of resonance radiation characteristic of the atomic species. The absorption of the cesium 8521-Å line and the mercury 2536-Å line are discussed, and a transmission curve is predicted for light showing atomic hyperfine structure, line broadening, and source self-absorption. A mercury radiation probe was used to determine the neutral efflux from a flight-model electron-bombardment engine. A cesium probe was also tested using a simulated cesium ion engine. (auth)

18686 CHEMISTRY OF THE ACTINIDE ELEMENTS. B. B. Cunningham (Univ. of California, Berkeley). Ann. Rev. Nucl. Sci., 14: 323-46(1964).

Actinide isotopes discovered since 1958 are reported. A brief account is given of the discoveries of elements 99 to 103. Results on the determination of electronic ground-state configurations and the spectroscopic and magnetic properties of the actinides is mentioned. Work is reviewed on the preparation and study of Ac, Th, Pa, U, Np, Pu, Am, Cm, Bk, and Cf in the metallic state, and on the extension of basic crystallographic and thermodynamic data on these elements and their compounds. 171 references. (M.J.T.)

18687 EQUILIBRIUM FRACTIONS FOR AN OXYGEN BEAM (15-50 kev) IN 17 GASES AND VAPORS. A. B. Wittkower, P. H. Rose, R. P. Bastide, N. B. Brooks, and L. Hopwood (High Voltage Engineering Corp., Burlington, Mass.). Can. J. Phys., 43: 404-10(Mar. 1965).

The equilibrium fractions of O^-, O^+, and O^{2+} were measured from 15 to 50 kev for the charge-changing of an O^+ beam in the following gases and vapors: hydrogen (H_2), helium (He), nitrogen (N_2), oxygen (O_2), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), nitrous oxide (N_2O), deuterium (D_2), water (H_2O), ammonia (NH_3), methane (CH_4), sulfur hexafluoride (SF_6), butane (C_4H_{10}), 2,2-dimethylpropane

(C_5H_{12}), and carbon dioxide (CO_2). The neutral fraction, O^0, may be inferred from the results. (auth)

18688 DETERMINATION OF THE MEAN FREE PATH OF SLOW ELECTRONS BY THE MEASUREMENT OF BACK-DIFFUSION IN HELIUM AND ARGON. O. J. Orient (Polytechnical Univ., Budapest.). Can. J. Phys., 43: 422-31 (Mar. 1965).

In the theoretical examination of back-diffusion Varney found a relation between the extent of the back-diffusion of electrons starting from the cathode and the distance to the cathode. When adequate conditions are ensured the dependence of back-diffusion on distance permits the determination of the mean free path of the electrons. A test device was developed to measure back-diffusion as a function of the distance to the cathode, for electrons that have an energy distribution corresponding to the specified pressure and the field intensity. From the dependence on distance, mean free paths for helium and argon gases in the range from X/p = 0.5 to 5 volts/cm.mm Hg were determined. The results are in fair accordance with the mean free paths computed by Barbiere from electron-energy distribution values. Variances were found, however, with Townsend's and Bailey's data, particularly in the case of argon, where the free path of electrons depends greatly on velocity. (auth)

18689 EFFECTS OF L-SHELL ELECTRONS ON THE POLARIZATION OF ELASTIC SCATTERING OF GAMMA RAYS. S. Anand, M. Singh, and B. S. Sood (Punjabi Univ., Patiala, India). Current Sci. (India), 34: 45(Jan. 20, 1965).

The effects of L-shell electrons on the polarization of elastic scattering of gamma rays from lead were investigated. Comparison of experimental values with theoretical calculations confirmed previous results that incomplete isolation of coherent scattering from incoherent scattering tends to lower the observed values of percentage polarization and the effect of L-shell electrons, if any, is small and does not show itself above experimental errors. Data are tabulated. (P.C.H.)

18690 AN EXPERIMENTAL STUDY OF THE BACK-SCATTERING OF 5.3-Mev ALPHA PARTICLES FROM PLATINUM AND MONEL METAL. D. H. Walker (National Bureau of Standards, Washington, D. C.). Intern. J. Appl. Radiation Isotopes, 16: 183-9(Mar. 1965).

The angular and energy distributions of the α-particles backscattered from essentially weightless sources of polonium-210 deposited on platinum and on monel metal were measured. It was found that the backscattering occurs only at angles close to the plane of the mounting, i.e., within 15°, and that the backscattered α-particles are distribu'ed over the entire energy range. Numerical integration of the angular distribution gave 3.1 and 2.1% backscattering for platinum and monel, respectively. (auth)

18691 ANGULAR DISTRIBUTIONS OF ARGON-SPUTTERED LITHIUM. R. P. Stein (Lockheed Corp., Sunnyvale, Calif.), V. Malakhof and Harold P. Smith, Jr. J. Appl. Phys., 36: 1504-6(Apr. 1965).

Measurements of the angular distribution of lithium atoms that were sputtered in the plane of incidence by argon atoms of 400 ev were carried out at angles of ion-beam incidence ranging from 30 to 80°. (C.E.S.)

18692 A NEW TREATMENT OF THE K-LL AUGER SPECTRUM. W. N. Asaad (Univ. of Munster, Ger.). Nucl. Phys., 66: 494-512(May 1965).

A new treatment of the K-LL Auger spectrum, based on intermediate coupling as well as configuration interaction, was accomplished. The Auger line intensities were obtained using the transition probability amplitudes computed by Archard, Rubenstein, and Snyder, by Burhop and by Callan. The required electrostatic and spin-orbit matrix elements were deduced from the electron binding energies, tabulated by Siegbahn et al. and from the semi-empirical expressions for Slater's integrals given by Hörnfeldt. Results obtained with the transition amplitudes of Archard and of Rubenstein and Snyder, for Z ranging from 12 to 36, indicate that nearly all the existing discrepancies between theory and experiment for low Z have now been completely removed. In particular, the relative intensities of the sp and p^2 groups of lines, normalized to s^2, are now in remarkable agreement with experiment. Also the relative line intensities of the K-LL Auger spectrum for krypton, Z = 36, agree excellently with the experimental values of Erman et al. for bromine, Z = 35. For intermediate atomic number, when use is made of Callan's transition amplitudes, configuration interaction raises the previously calculated values of all these relative intensities in such a way that the new calculated results are in better agreement with experiment. (auth)

18693 EFFECT OF THERMAL VIBRATIONS ON THE ANOMALOUS TRANSMISSION OF X-RAYS IN ZINC CRYSTALS. A. Merlini and S. Pace (C.C.R.-Euratom, Ispra, Italy). Nuovo Cimento (10), 35: 377-90(Jan. 16, 1965).

Earlier studies of diffraction of x rays through thick lamellas of zinc crystals have shown that anomalous transmission of x rays takes place in zinc if the x-ray beam is reflected on the (0002) planes. Absolute measurements of integrated intensities were done on the beams transmitted and reflected through thick crystals ($\mu t \approx 25-30$) of zinc in the temperature range from 80 to 525°K. The characteristic radiation CuKα reflected by a quartz monochromator was used in all the measurements. The plot of the logarithm of the integrated intensities vs temperature is a straight line, over the temperature range investigated. Since the slope of the plot is proportional to dM/dT, where exp [−M] is the Debye-Waller factor and T is the absolute temperature, it was possible to determine a Debye temperature for the c-component of the mean square vibration displacement of zinc: $\Theta \approx 170$°K. This value of the Debye temperature was obtained by assuming that the temperature-dependence of the imaginary part of the atomic scattering factor is given by the factor exp [−M], an hypothesis which is supported by experiments on the temperature-dependence of the intensities diffracted in anomalous transmission through crystals of germanium. (auth)

18694 EXPERIMENTAL STUDY OF THE COLLIMATION PROBLEM IN A HIGH-INTENSITY MOLECULAR BEAM. G. T. Skinner and J. Moyzis (Cornell Aeronautical Lab., Buffalo). Phys. Fluids, 8: 452-8(Mar. 1965).

The discrepancy between the experimentally observed beam intensities obtained with nozzle sources, and the intensities predicted by the inviscid theory is generally attributed to viscous effects upstream of the skimmer. Experiments are described which show the scattering of a 1.2-ev nitrogen beam downstream of a skimmer or collimator. Such scattering can only result from collisions with slow molecules, traveling with the beam, coming from the viscous region upstream. Elimination of this scattering was accomplished by limiting the radial extent of the flow field approaching the skimmer, and beams were obtained having the theoretically available intensity. (auth)

18695 THE ELECTRIC DIPOLE MOMENT OF AN ATOM. P. G. H. Sandars (Oxford Univ.). Phys. Letters, 14: 194-6(Feb. 1, 1965).

It is argued that if relativity is taken into account an atom can have an electric dipole moment, and that in the heavy alkalis the electric dipole moment of the atom may be considerably larger than that of the free electron. (L.B.S.)

18696 EXCITATION OF H-ATOMS BY FAST ATOM IMPACT. R. M. May (Univ. of Sydney). Phys. Letters, 14: 198-9(Feb. 1, 1965).

Expressions for the formation of highly excited bound states of hydrogen atoms are obtained using the Born approximation. (L.B.S.)

18697 THE ANGULAR DEPENDENCE OF RESONANT SCATTERING OF LOW-ENERGY ELECTRONS IN HELIUM. H. Ehrhardt and G. Meister (Universitat, Freiburg i B.). Phys. Letters, 14: 200-201(Feb. 1, 1965). (In German)

It is concluded from measurement of the resonant scattering of low energy electrons in helium that the He^- ions producing the 19.3 ev resonance have the $1s2s^2\ ^2S$-configuration. It consists of the addition of 2s-electrons to the low excited states of helium, $1s2s\ ^3S$ (19.8 ev) and $1s2s\ ^1S$ (20.6 ev). (L.B.S.)

18698 ANOMALOUS TRANSMISSION OF X-RAYS IN PERFECT SINGLE GERMANIUM CRYSTALS AT LIQUID NITROGEN TEMPERATURE. D. Ling and H. Wagenfeld (Univ. of Melbourne). Phys. Letters, 15: 8-10(Mar. 1, 1965).

It is predicted that the Borrmann effect—the temperature dependence of the anomalous x-ray transmission in perfect single crystals—will increase (that is, the x-ray absorption will decrease) when the crystal temperature is lowered. The ratio of the transmitted integrated intensities at 77 and 292°K was measured for the Ge 220 reflection using Mo K_α and Ag K_α radiation and for the 440 reflection using Ag K_α radiation, for two crystals of thickness 0.060 and 0.231 cm. Results are in reasonable agreement with those calculated from an expression derived using the equation of Zachariasen or Kato for the integrated intensity of the reflected beam. (M.J.T.)

18699 THE MÖSSBAUER EFFECT FOLLOWING α-DECAY: ITS RELATION TO HEAT CONDUCTION IN SOLIDS. J. G. Mullen (Purdue Univ., Lafayette, Ind.). Phys. Letters, 15: 15-16(Mar. 1, 1965).

Stone and Pillinger observed the Mössbauer effect in NpO_2 after α decay of ^{241}Am and β decay of ^{237}U; the intensity of the spectral lines after α decay was found to be considerably smaller. It is pointed out that this result may be explained on the basis of thermal aftereffects associated with α decay. Experiments are proposed to test this hypothesis and the one that the reduction is due to a difference in the local environment of the Mössbauer nucleus after α decay resulting from radiation damage. A lower limit of the mean thermal conductivity of NpO_2 is derived from the data of Stone and Pillinger. (M.J.T.)

18700 MMN COSTER-KRONIG TRANSITIONS OF KRYPTON. W. Mehlhorn (Universitat, Munster, Ger.). Phys. Letters, 15: 46-7(Mar. 1, 1965).

Measurements were carried out of the M_2, $_3M_4$, $_5N$ Coster-Kronig transitions of Kr. Spectra of Auger and Coster-Kronig electrons of the M_2 and M_3 shell are presented for primary electron energies of 290 and 2000 ev, and absolute energies and relative intensities of the transitions are given. Experimental results agree qualitatively with theoretical predictions that the probability for a Coster-Kronig transition is much greater than that for an Auger transition, if the former is possible energetically. (M.J.T.)

18701 THEORY OF THE EXCITATION OF THE 4686-Å LINE OF He^+ BY ELECTRON IMPACT. Edward T. P. Lee and Chun C. Lin (Univ. of Oklahoma, Norman). Phys. Rev., 138: A301-4(Apr. 19, 1965).

The cross sections for the production of He^+ ion in the 4S state by single-electron collisions with neutral helium atoms in the ground state were calculated by the Born approximation at various incident-electron energies from 200 to 450 ev. These cross sections range from 8.2×10^{-21} to 6.6×10^{-21} cm^2. By using the ionization-excitation cross sections of the 4P and 4D states calculated by Dalgarno and McDowell and by extending their calculations to 4F, the cross sections of the excitation of the $n = 4 \rightarrow n = 3$ transitions of He^+(4686 Å) were computed. It was found that the transition $4S \rightarrow 3P$ contributes about 90% of the total radiation of the various members of the $n = 4 \rightarrow n = 3$ group. The theoretical cross sections of the 4686-Å radiation agree with the experimental values to within 15%. It is concluded that the observed 4686-Å radiation can be ascribed mainly to direct ionization-excitation to the $n = 4$ states of He^+ by single-electron impact, and no evidence is found for any indirect excitation mechanism which is responsible for a significant portion of the population of the 4S state of He^+. (auth)

18702 ELASTIC RESONANCES IN ELECTRON SCATTERING FROM He, Ne, Ar, Kr, Xe, AND Hg. C. E. Kuyatt, J. Arol Simpson, and S. R. Mielczarek (National Bureau of Standards, Washington, D. C.). Phys. Rev., 138: A385-99 (Apr. 19, 1965).

The transmission of electrons through the rare gases and mercury vapor was examined as a function of electron energy, with energy resolution of about 0.04 ev. Many anomalies (resonances) localized in energy were observed, totaling 11 in helium, six in neon, two each in argon and krypton, five in xenon, and 13 in mercury. The interpretation of these resonances in terms of compound negative ion formation is discussed, and in several cases electron configurations are assigned to the negative ions. In helium, neon, xenon, and mercury, sharp decreases in transmission are observed which are attributed to the onset of inelastic processes. Definite identification of the inelastic processes in the case of helium permits calibration of the absolute electron energy scale to within ±0.03 ev. (auth)

18703 IDENTIFICATION OF ENERGY LEVELS OF NEGATIVE IONS. U. Fano and J. W. Cooper (National Bureau of Standards, Washington, D. C.). Phys. Rev., 138: A400-2(Apr. 19, 1965).

Levels of He^- at 57.1 and 58.2 ev and of Hg^- at 4.0, 4.2, and 4.8 ev are identified spectroscopically as $2s^22p\ ^2P$, $2s2p^2\ ^2D$, $6s6p^2\ ^4P_{\frac{1}{2},\frac{3}{2},\frac{5}{2}}$, respectively. The identification procedure, which combines elements of spectroscopy and collision theory, is described. (auth)

18704 EXCITATION OF 10-Mev H^0 ATOMS IN NEUTRAL- AND CHARGED-PARTICLE COLLISIONS. Klaus H. Berkner, Selig N. Kaplan, George A. Paulikas, and Robert V. Pyle (Univ. of California, Berkeley). Phys. Rev., 138: A410-17(Apr. 19, 1965). (UCRL-11460)

Ten-Mev hydrogen atoms with a distribution of excited states were produced by collisional dissociation of 20-Mev H_2^+ ions. The populations of the higher excited levels were removed by Lorentz ionization, and the levels were then repopulated by collisional excitation of the atoms in molecular or weakly ionized hydrogen targets. The populations of the levels $n = 6$ to 9 were determined by a second Lorentz ionization. For collisions with electrons and ions in hydrogen-plasma targets, cross sections for transitions from the levels $n = 5$, 6 to $n' = 6$, 7, 8, 9, and upper limits for the transitions $n = 1$ or 4 to $n' = 6$ or 7 were obtained. These are compared with calculations in the first Born, Bethe, and impact-parameter approximations; good agreement is found for all transitions, although those with $\Delta n = 2$ are somewhat larger than calculated. For molecular-hydrogen targets, transitions are observed from the sum of all levels with $n \leq 4$, 5, 6 to levels $n' = 6$, 7, 8, and 9. Cross sections for the individual transitions from $n = 5$, 6 to the levels $n' = 6$, 7, 8, and 9 were deduced from these results. These cross sections differ from those for charged-particle collisions in that they are smaller by about 3 orders of magnitude, and the ratios of cross sections with $\Delta n > 1$ to those of $\Delta n = 1$ are larger than in the charged-particle case. (auth)

18705 PHOTOIONIZATION CROSS SECTION OF NEON. Kenneth G. Sewell (LTV Research Center, Dallas). Phys. Rev., 138: A418-21(Apr. 19, 1965).

The photoionization cross section of neon was computed for the energy range from threshold to 11.5 Ry and compared with recent experimental results. Hartree-Fock radial functions were used to describe both the initial and final states of the transition. (auth)

18706 DISPERSION THEORY OF THE KONDO EFFECT. H. Suhl (Univ. of California, San Diego, La Jolla). Phys. Rev., 138: A515-23(Apr. 19, 1965).

According to recent work by Kondo, the scattering cross section of an electron in exchange interaction with a paramagnetic impurity immersed in a Fermi sea of electrons has a logarithmic infinity as the electron energy approaches the Fermi energy. This problem is examined by means of the Chew-Low method first devised for meson-nucleon scattering. It is found that the singularity is replaced by a resonant scattering close to the Fermi level. (auth)

18707 REVISION OF ELECTRON BINDING ENERGIES IN LIGHT ELEMENTS. A. Fahlman, K. Hamrin, R. Nordberg, C. Nordling, and K. Siegbahn (Uppsala Univ.). Phys. Rev. Letters, 14: 127-9(Feb. 1, 1965).

The binding energies of electrons in the L_I shells of Al, Mg, and O were measured by electron spectroscopy. Notable differences from some values obtained from x-ray spectra were found. Binding energies are proposed for L_I electrons of elements from Z = 8 to 23. (D.C.W.)

18708 PAIRING ENERGY OF LITHIUM AND BORON IN SILICON. W. G. Spitzer (Univ. of Southern California, Los Angeles) and M. Waldner. Phys. Rev. Letters, 14: 223-4(Feb. 15, 1965).

The absorption spectra of samples of B-doped Si compensated with Li were measured between room temperature and about 200°C. Analysis of the data for a $^{10}B-^{7}Li$ sample gave a value of 0.39 ev for the pairing energy of the B–Li pairs. With a $^{10}B-^{6}Li$ sample, a value of 0.36 to 0.38 ev was obtained. (D.C.W.)

18709 IONIZATION OF THE HYDROGEN MOLECULE BY ELECTRON IMPACT NEAR THRESHOLD. Donald D. Briglia and Donald Rapp (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Rev. Letters, 14: 245-7(Feb. 22, 1965).

The cross section for ionization of molecular hydrogen was measured as a function of electron energy. A direct-ionization model failed to predict the correct threshold law for H_2^+. It was concluded that, near threshold, ionization of H_2 occurs primarily through nondirect processes and that the distribution of vibrational states of H_2^+ is very uncertain. (D.C.W.)

18710 CHARGE-STATE CORRELATIONS IN Ar^+-Ar COLLISIONS. Edgar Everhart and Quentin C. Kessel (Univ. of Connecticut, Storrs). Phys. Rev. Letters, 14: 247-9 (Feb. 22, 1965).

Single collisions of Ar^+ on Ar at 25 to 150 kev were studied using a coincidence scattering device. For the reaction $Ar^+ + Ar \rightarrow Ar^{m+} + Ar^{n+} + (m+n-1)e$, the charge states m and n of both particles from the same large-angle collision were determined. The probabilities of observing m and n in coincidence were found, and the inelastic energy loss for the (m,n) reaction was determined. No correlation between m and n was found, and an interpretation of the observations was developed. (D.C.W.)

18711 AUTOIONIZATION AND THE VIBRATIONAL EXCITATION OF H_2^+. Philip H. Doolittle and Richard I. Schoen (Boeing Scientific Research Labs., Seattle). Phys. Rev. Letters, 14: 348-9(Mar. 8, 1965).

Electron retarding-potential techniques were used to show that autoionization not only produces peaks in plots of photoionization cross sections vs wavelength, but can also change the energy distribution of the electrons emitted. The measurements were made on molecular hydrogen. (D.C.W.)

18712 IMPORTANCE OF COUPLING FOR INELASTIC COLLISIONS BETWEEN PROTONS AND HYDROGEN ATOMS. S. E. Lovell (Univ. of Wisconsin, Madison) and M. B. McElroy. Proc. Roy. Soc. (London), Ser. A, 283: 100-14(Jan. 5, 1965).

The importance of coupling for fast collisions between protons and hydrogen atoms is studied with the two-centered expansion in atomic eigenfunctions proposed by Bates. Cross sections are evaluated for reactions $H^+ + H(1s) \rightarrow H(1s) + H^+$, $H^+ + H(1s) \rightarrow H(2s) + H^+$, and $H^+ + H(1s) \rightarrow H^+ + H(2s)$. The effect of a single intermediate state, either 1s or 2s, is considered. For the non-resonance processes, it is found that the cross sections may be substantially increased by passage through intermediate state for incident energies less than about 10 kev, tending towards equality with decrease in relative velocity. Results obtained for the symmetrical resonance reactions are in good agreement with the two-state solutions of McCarroll. (auth)

18713 THE DIRECT CALCULATION OF THE FIRST-ORDER DENSITY MATRIX FOR ATOMS. G. G. Hall, L. L. Jones, and D. Rees (Univ. of Nottingham, Eng.). Proc. Roy. Soc. (London), Ser. A, 283: 194-202(Jan. 6, 1965).

The theory of isoelectronic sequences of atoms was developed as a perturbation theory and is extended to the calculation of the first-order density matrix. It is shown that the calculation of the first-order contribution to this matrix can be reduced to the solution of a number of one-electron equations. These equations were solved for the He ground state, the He ^3S state, and the Li ground state. From the density matrix, mean values of one-electron operators can be derived by integration. A variety of these mean values is quoted, and the significance of the stable values discussed. From the density matrix the natural orbitals can be derived, and these are found to be identical with the unrestricted molecular orbitals to terms of zero and first order. (auth)

18714 IONIZATION OF ATOMIC HYDROGEN BY ELECTRON IMPACT. M. R. H. Rudge and M. J. Seaton (Univ. of London). Proc. Roy. Soc. (London), Ser. A, 283: 262-90(Jan. 6, 1965).

The ionization problem is first formulated on the assumption of short-range potentials, particular attention being paid to the treatment of electron exchange. For the case of Coulomb potentials, the asymptotic form of the wave function is obtained for positive total energy and for zero energy. An exact integral expression is obtained for the scattering amplitude, and threshold laws are deduced. At threshold, the differential cross section tends to a finite value for the case in which the total potential energy is negative in the asymptotic region. The total cross section varies near threshold as a linear function of energy. Results of three experimental determinations of the cross section are discussed. A number of calculations are made, all in the approximation of using a plane wave for the incident electron. The cross section expression which has usually been employed in Born approximation ionization calculations is correct when the two electrons have opposite spins. An alternative form of the Born approximation for ionization, which is more closely analogous to that used for excitation, is shown to give improved results. The Born-Oppenheimer approximation gives poor results, but allowance for exchange in other approximations gives an improvement in the agreement with experiment. (auth)

18715 DEFORMATION OF THE THOMAS-FERMI ATOMIC MODEL BY NON-SPHERICALLY SYMMETRIC POTENTIAL FIELDS. E. Teuchert (Universitat, Cologne). Z. Physik, 183: 394-401(1965). (In German)

The conditions are deduced for the exact solution of the Thomas-Fermi-equation for an atom or ion, which is deformed by non-spherical fields. A numerical method for the solution of the associated integral equation is shown. Explicit calculations were performed for the polarizability of some ions and for the energy required to bring an electron by steps from inside the model to infinity. (auth)

18716 MEAN ENERGY EXPENDITURE FOR THE FORMATION OF AN ELECTRON THROUGH COLLISION IONIZATION IN THE MICROWAVE FIELD. Jochen Booz and Heinrich George Ebert (Universitat, Gottingen, Ger.). Z. Angew. Phys., 18: 285-90(1965). (In German)

The mean energy W_e consumed in a microwave gas discharge for the production of an electron was measured. The gas discharge occurred in a hollow resonator (H_{011}) whose resonance frequency was approximately 10 BHz. From the reflection of a measurement signal of calibrated frequency at the input of the resonator, the time variation of its resonance frequency after the end of the gas discharge was measured. The theories of Margenau and Slater were used to calculate the electron density and the electron numbers from the measured resonance frequency displacements. The energy given by the microwave field for the production of electrons was calculated from the electric field strength. A measurement method with which the increase of the field strength before the discharge can be measured is described. The magnitude of W_e for air, nitrogen, hydrogen, and argon is given as a junction of $\overline{X}_{eff}/\underline{p}$. It is shown that W_e at high $\overline{X}_{eff}/\underline{p}$ is constant for all gases and is about equal to the mean energy per ion pair W, measured at electron energies between 20 kev and 3 Mev. (tr-auth)

18717 SMALL ANGLE SCATTERING OF NEUTRONS FOR THE INVESTIGATION OF LATTICE HOLES. Josef Christ, Werner Schilling, Werner Schmatz, and Tasso Springer (Technische Hochschule, Minich and Kernforschungsanlage, Julich, Ger.). Z. Angew. Phys., 18: 295-308(1965). (In German)

The most important possibilities for the application of the small-angle scattering of long-wave neutrons are de-

scribed and compared with the conventional method of x-ray small-angle scattering. Various measuring arrangements are discussed. Neutron scattering is shown to be especially advantageous in investigations of holes in cold-formed or irradiated solids. Investigations on copper and quartz made at the FRM Reactor in Munich are reviewed. (tr-auth)

18718 ATOMIC MIGRATION IN CRYSTALS. L. A. Girifalco. New York, Blaisdell Publishing Company, 1964. 170p. $3.75.

An introduction to the concepts and theory of solid state diffusion is presented in an elementary way, based on the ideas of the geometry of the crystal lattice and the nature of interatomic forces. Basic concepts of diffusion theory are discussed, including atomic jump mechanisms, point defects, thermal vibrations, activation energy, random walk, Fick's laws, and the diffusion coefficient. Diffusion in metals, ionic crystals, covalent crystals, and along grain boundaries is described. A brief survey is given of pressure effects on diffusion, the electron wind, and diffusion in a temperature gradient. (M.J.T.)

18719 ATOMIC SPECTRA AND THE VECTOR MODEL. Second Edition. Chris Candler. New York, D. Van Nostrand Company, Inc., 1964. 419p.

Atomic spectra are discussed in the framework of the vector model. Chapters are included on the hydrogen atom, alkali doublets, alkaline earths, absorption spectra, Zeeman effect, Paschen-Back effect, periodic system, doublet laws, displaced terms, elements of the short and long periods, lanthanides and actinides, line-intensity measurement, sum rules and jj coupling, hyperfine structure, and quadrupole radiation. Grotian diagrams are given for all arc spectra except those of rare earths and for some spark spectra. (M.J.T.)

Cosmic Radiation

See also Elementary Particles and Radiations. Nuclear Properties and Reactions.

Refer also to abstract 18673.

18720 (CRGP-1208) TRAJECTORY-COMPUTED VERTICAL THRESHOLD RIGIDITIES FOR 85 NEUTRON MONITOR STATIONS. M. Kodama (Atomic Energy of Canada Ltd., Chalk River (Ontario). Deep River Lab.). Nov. 1964. 39p. (AECL-2134). Dep.; $1.00(AECL).

As an extension of the trajectory calculations for asymptotic directions of cosmic ray particles, the vertical threshold rigidities for 85 cosmic ray stations have been determined with an accuracy of 0.1 gv. It is shown that the threshold rigidities are fairly sensitive to the difference of the geomagnetic field simulation adopted for the computation. The values are evaluated by applying them to typical cosmic ray disturbance events throughout the last solar cycle; namely a Forbush decrease in July 1959 and two solar flare particle increases in February 1956 and November 1960. (auth)

18721 (NP-14812) INTENSITY OF 80- TO 200-Mev PROTONS OVER FORT CHURCHILL ON 26 AUGUST 1960. P. S. Freier and C. J. Waddington (Cosmic Ray Group, Univ. of Minnesota, Minneapolis). Nov. 1964. Contract Nonr-710(60). 20p. (CR-73).

The intensity and energy spectrum of primary cosmic ray protons having energies between 80 and 200 Mev have been studied in nuclear emulsions flown on 26 August 1960 over Fort Churchill. The upper limit to the intensity between 80 and 150 Mev of 53 ± 6 protons/$m^2 \cdot sec \cdot sterad$ obtained in this experiment is compared with the value of 121 ± 6 protons/$m^2 \cdot sec \cdot sterad$ obtained from observations made just prior to and just after this experiment. The reasons for this difference are discussed, and it is concluded that it is unnecessary to make any assumptions for a relaxed modulation mechanism of for continuous solar emission of low energy protons. (auth)

18722 (UCRL-7633) NEAR-EARTH, HIGH-LATITUDE SATELLITE MEASUREMENTS OF COSMIC-RAY FLUX IN 1961. F. D. Seward and H. N. Kornblum, Jr. (Lawrence Radiation Lab., Univ. of California, Livermore). Dec. 31, 1963. Contract W-7405-eng-48. 28p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

In September and November 1961, measurements of cosmic ray flux were made from two Air Force satellites in near-polar orbits. The observed edges of the polar cosmic ray plateaus are given as a function of position over the earth's surface. Using existing expansions to calculate the earth's magnetic field, the observed plateau edges do not lie exactly in conjugate regions. The average position of the edge is at L = 2.9, but deviations from this value are observed in certain locations. A 5 to 10% maximum in counting rate was consistently observed at the edge of the plateaus. This is interpreted as being due to re-entrant cosmic ray albedo. From these re-entrant albedo observations the omnidirectional interplanetary cosmic ray flux in November 1961 is deduced to be $2.6^{+0.3}_{-0.5}$ particles/cm^2-sec. (auth)

18723 (FTD-TT-64-1316(p.185-93)) THE DISTRIBUTION OF COSMIC-RAY INTENSITY IN THE ATMOSPHERE UP TO AN ALTITUDE OF 500 km. Yu. G. Shafer, V. D. Sokolov, N. G. Skryabin, V. F. Lyutenko, A. V. Yarygin, and R. B. Salimzibarov. Translated from Kosmich. Issled., 2: 928-32(1964).

In the period from 1958 to 1963, during a decrease in solar activity, cosmic ray measurements were carried out by means of geophysical rockets and satellites of the Kosmos type. Geophysical rockets were equipped with single counters and ionization cameras. Satellites of the Cosmos type were equipped with ionization cameras, single counters, and counting telescopes for measuring the cosmic ray albedo. Rocket and satellite launchings were scheduled for days without magnetic storms and quiet sun. Primary cosmic rays were measured at heights of 100–500 km. The cosmic ray albedo measured by rockets equipped with special devices was found to be insignificant. Numerical values of measurement data show a slight increase in particle count with height. No indications were found which would associate systematic variations in the intensity of primary cosmic rays with the eleven-year cycle of solar activity. (ATD)

18724 (FTD-TT-64-1316(p.194-8)) SOME RESULTS OBTAINED IN THE MEASUREMENT OF EAST-WEST ASYMMETRY IN THE INTENSITY OF PRIMARY COSMIC RADIATION. Yu. G. Shafer, V. D. Sokolov, N. G. Skryabin, S. K. Dergeim (Dergeym), and R. B. Salimzibarov. Translated from Kosmich. Issled., 2: 933-8(1964).

A brief description is presented of the experimental installation employed to measure the effect of the east-west asymmetry in cosmic radiation. The measurements were carried out within an altitude interval of 100–500 km. The lower boundary of albedo particle intensity and the effect of the east-west asymmetry of primary cosmic radiation were determined from the data of the experiment. (auth)

18725 DAILY VARIATION OF COSMIC RAY INTENSITY ASSOCIATED WITH SOLAR DISTURBANCES. Ch. V. Sastry (Yale Univ., New Haven). Current Sci. (India), 33: 676-7(Nov. 20, 1964).

The daily variation of the cosmic-ray intensity associated with solar activity was investigated using the solar flare index published by Dodson and Hedeman for each day of the IGY. (D.C.W.)

18726 SPECTRUM OF THE PARTICLE RANGES OF THE HARD COSMIC RADIATION COMPONENT IN A CYLINDRICAL SCINTILLATOR. V. Zlatarov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 12: 261-71(1964). (In Russian)

The response to a hard cosmic radiation component of a scintillation counter with a cylindrical scintillator is studied. It is pointed out that under certain conditions the spectrum of the particle ranges in the scintillator should be similar to the spectrum of initial electrical impulses.

A method is suggested for calculating the spectrum ranges and is applied in case of a cylindrical scintillator with a vertical axis. Indications are given for practical application of the formulas derived for determining the spectrum ranges. The problem is considered of simplifying the calculus when high precision is not required. (auth)

18727 THE ENERGY DEPENDENCE OF THE ABUNDANCE OF LITHIUM, BERYLLIUM, AND BORON IN THE PRIMARY COSMIC RADIATION: OBSERVATIONS AT FORT CHURCHILL. G. D. Badhwar, S. N. Devanathan, and M. F. Kaplon (Univ. of Rochester, N. Y.). J. Geophys. Res., 70: 1005-17(Mar. 1, 1965).

The relative abundances of Li, Be, B, and the S-group nuclei were determined at two different energies by means of a pure nuclear emulsion stack flown from Fort Churchill, Canada ($\lambda = 70.5°$), on August 4, 1962, under a total of 4.7 g/cm^2 of residual atmosphere. The ratio of the L to S nuclei, Γ_{LS}, at the top of the atmosphere between 200 and 70 Mev/n and > 700 Mev/n was determined to be 0.41 ± 0.08 and 0.19 ± 0.03, respectively. The results of both the absolute flux values of L- and S-group nuclei, as well as their ratios, are in accord with other investigations. Combined with the evidence from the measurements of Γ_{He_3He} in the same stack, the results indicate that low-energy cosmic-ray nuclei have traversed about twice as much hydrogen as high-energy particles. The results rule out an accelerating mechanism of the Fermi type, but can be explained by a source-trapping mechanism. (auth)

18728 MEASUREMENT OF THE COSMIC-RAY NEUTRON FLUX AT 4.6 BILLION VOLTS GEOMAGNETIC CUTOFF RIGIDITY. G. Boella (Universita, Milan and Istituto Nazionale di Fisica Nucleare, Milan), G. Degli Antoni, C. Dilworth, M. Panetti, L. Scarsi, and D. S. Intriligator. J. Geophys. Res., 70: 1019-30(Mar. 1, 1965).

In a series of balloon flights, at 4.6 Bev geomagnetic cutoff rigidity (corresponding to the geomagnetic latitudes of about 46° in northern Italy and about 42° in southern New Mexico, United States), with a light-weight neutron detector, the flux of the cosmic ray neutrons in the atmosphere was investigated in the energy range from thermal to about 20 Mev. The energy spectrum proposed by Newkirk was found to be in agreement with the experimental results. Values of the integrated neutron flux at different atmospheric depths are given; by extrapolating to zero pressure, the leakage flux was determined to be 0.45 ± 0.07 neutrons cm^{-2} sec^{-1}. (auth)

18729 THE ENERGY SPECTRUM OF PRIMARY COSMIC-RAY PROTONS OF ENERGY (4 + 16) Gev FROM SIMULTANEOUS BALLOON FLIGHTS MADE FROM TEXAS (U.S.A.) AND HYDERABAD (INDIA). R. R. Daniel and N. Sreenivasan (Tata Inst. of Fundamental Research, Colaba, India). Nuovo Cimento (10), 35: 391-7(Jan. 16, 1965).

The energy spectrum of primary cosmic protons of energy (4–16) Bev was determined using nuclear emulsions flown simultaneously from Texas (U.S.A.) and Hyderabad (India) on March 27, 1962. The method depends on the determination of the flux of protons at the two stations from observations made on the number of nuclear disintegrations induced by relativistic singly charged particles in a given volume of the exposed emulsions. An integral energy spectrum of the form $N(\geq E) = C/(m_0c^2 + E)^\gamma$ was fitted to the data and the value of γ determined as 1.42 ± 0.11. (auth)

18730 MAGNETIC-CLOUD-CHAMBER OBSERVATIONS OF LOW-ENERGY COSMIC-RAY ELECTRONS. James W. Schmoker and James A. Earl (Univ. of Minnesota, Minneapolis). Phys. Rev., 138: B300-?(Apr. 12, 1965).

The flux of cosmic electrons in the energy range 45 < E < 150 Mev was measured at balloon altitudes over a wide range of geomagnetic latitudes. The data obtained led to the following conclusions: The flux of primary electrons in the above energy range is less than 35 particles/m^2-sec-sr. The geomagnetic cutoff rigidity at Fort Churchill, Manitoba, is less than 45 Mv; this is significantly less than the cutoff expected from the earth's interval field alone. (auth)

18731 SPATIAL DISTRIBUTION, ENERGY SPECTRA, AND TIME VARIATIONS OF ENERGETIC ELECTRONS (E > 50 kev) AT 17.7 EARTH RADII. Michael D. Montgomergy, Sidney Singer, J. P. Conner, and E. E. Stogsdill (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 14: 209-13(Feb. 15, 1965). (LA-DC-6802)

The results of measurements of the spatial distribution, energy spectrum, and time variations of electrons with energies > 50 kev at 17.7 earth radii are presented. The results show that the energetic electron events cluster about the geomagnetic equatorial plane and that a strong dawn-to-dusk asymmetry exists. (D.C.W.)

18732 HEAVY PARTICLES IN SOLAR COSMIC RAYS. Zyun Nishimura (Tokyo Univ.). Uchusen-Kenkyu, 8: 755-65(Sept. 1963). (In Japanese)

Recent developments in the study of heavy particles are described, and a new idea for the acceleration phase of the particles is proposed. The results of observation are as follows: (1) the ratio of He to C, N, and O is essentially the same from event to event; (2) there is a large variation in the helium-to-proton ratio from event to event; and (3) the heavy particles seem to have the same rigidity spectrum as the protons. The three observations indicate that probably no simple explanation is possible for the characteristics of the heavy particles in the solar cosmic rays. These may be due either to the acceleration phase, the transit and modulation phase of the solar cosmic-ray event, or both. The acceleration phase is discussed. After passing through the preliminary acceleration, which is independent of the particle energies (a Fermi-type acceleration for slow particles), the particles may be further accelerated to higher energies by a betatron-type acceleration (a Fermi-type acceleration for relativistic particles). At the inflection point between the two types of acceleration, every nucleus has the same energy per nucleon. (Nucl. Sci. Abstr. Japan, 3: Sept. 1964)

Criticality Studies

See also REACTOR TECHNOLOGY — Criticality Studies.

Refer also to abstracts 18076 and 19363.

18733 (BNWL-19) SUBCRITICAL MEASUREMENTS WITH STORAGE CONTAINERS OF PLUTONIUM NITRATE SOLUTION. R. C. Lloyd and E. D. Clayton (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1965. Contracts AT(45-1)-1350 and AT(45-1)-1830. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Subcritical neutron multiplication measurements were performed with $Pu(NO_3)_4$ solutions in Pb–Cd shielded and unshielded storage cans. The measurements were made on planar arrays of 8 × 8 cans. From the results, it is concluded that for the unshielded cans, the critical number is ≥500 and ≥300 in the planar and double tiered arrays, respectively, while for the shielded cans, the critical number is ≥400 in the planar array. (D.L.C.)

18734 (CEA-R-2455) MESURES D'INDICES DE SPECTRE DANS LES MILIEUX MULTIPLICATEURS HOMOGENES. (Measurements of Spectral Indices in Homogeneous Multiplying Media). Jean-G. Bruna, Jean-Paul Brunet, Christian Clouet d'Orval, Jacques Kremser, Jean Moret-Bailly, Henry Tellier, and Philippe Verriere (Commissariat à l'Energie Atomique, Saclay (France). Centre d'Études Nucléaires). Sept. 1964. 57p. Dep.(mn).

Methods for computation of spectra in light water are available, and it is interesting to carry out at the same time experimental studies of simple media (such as solutions of fissionable salts) which allow quite direct comparisons with computed values. The spectral indices measurements were made with two small fission chambers, one containing deposited plutonium, the other deposited uranium-235. Their response, when neutron spectrum is modified, allows the epithermal part of the flux to be studied. The media studied with these chambers are fissionable solutions (of plutonium or 90 percent enriched uranium) which were made critical in bare cylindrical

geometry in the ALECTO reactor. If the ratio of the chambers is normalized to unity in a Maxwell spectrum, then the noted variation of the ratio of the counts Pu chamber/U-235 chamber reaches 1.4 in the range of the studied concentrations. (auth)

18735 (HW-79572) STUDY OF THE CHAIN REACTION IN PLUTONIUM. E. D. Clayton (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 8, 1963. Contract AT(45-1)-1350. 39p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Several hundred critical mass determinations were made of plutonium solutions in a Critical Mass Laboratory. This facility is especially designed and equipped to handle plutonium. A brief discussion is given of the experimental facility, its special features, and of the critical assemblies used in these experiments. Factors affecting criticality are presented and critical data given for plutonium; a few simple comparisons are made between plutonium and uranium. The results of Monte Carlo calculations of k, η, f for U and Pu in water systems are presented. Experimental methods of criticality measurement are discussed. Nuclear safety considerations and the need for critical mass data are briefly reviewed. New critical data on an intermediate spectrum critical assembly consisting of a homogeneous mixture of plutonium dioxide in plastic are presented. (auth)

18736 (K-1629) MINIMUM CRITICAL CYLINDER DIAMETERS OF HYDROGEN MODERATED U(4.9) SYSTEMS. C. E. Newlon (Oak Ridge Gaseous Diffusion Plant, Tenn.). Mar. 15, 1965. Contract W-7405-eng-26. 13p. Dep.; $1.00(cy), 1(mn) CFSTI.

From a review of recent experimental data for a homogeneous, hydrogen moderated and reflected $U(4.9)O_2F_2$ system, and correlation with 16-group transport theory calculation, it appears that the minimum critical, infinite length cylinder diameter is 12.1 inches for the hydrogen moderated and reflected UF_6 system. The maximum uranium density of the UF_6 is taken as 3.2 g. U/cc. Calculations indicate that the use of a 0.20 inch wall thickness stainless steel or nickel container may increase the assigned minimum critical cylinder diameter about 0.9 inch. (auth)

18737 CRITICALITY PROBLEMS. J. T. Daniels (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). J. Brit. Nucl. Energy Soc., 4: 23-30(Jan. 1965).

Control of the handling and storage of fissile materials to prevent accidental criticality may be applied on the basis of simple data for uranium and plutonium metal–water systems. More economical control may, however, be achieved by the use of later data now available on chemical compounds. Computational techniques were developed, which enable more realistic account to be taken of actual process plant configuration. Extensive management control is required and some of the special aspects of this control are discussed. (auth)

18738 PROPOSAL FOR A NEW RELATIVE UNIT OF REACTIVITY NAMED "ZERLIN." M. Srinivasan (Atomic Energy Establishment, Trombay, India). J. Nucl. Sci. Technol. (Tokyo), 2: 78-9(Feb. 1965).

A relative reactivity unit is defined, based on the reactivity value in fast neutron multiplying systems and heavy water lattice reactor at a period of 200 sec. It is called the inverse two hundred second period unit or ZERLIN (for ZERLINA, the Zero Energy Heavy Water Reactor at Trombay). A unit such as ZERLIN was found to be less sensitive to changes in core properties and hence more useful in practice than other units because of the period value chosen. (M.C.G.)

Direct Energy Conversion

18739 (NP-14830) THE DEVELOPMENT OF A LOW-TEMPERATURE CYLINDRICAL THERMIONIC GENERATOR. Quarterly Technical Report No. 3, December 30, 1964. (Radio Corp. of America, Lancaster, Pa. Direct Energy Conversion Dept.). Contract AF33(615)-1547. 49p.

The evaluation and analysis of Type A-1198B insulated converters provided additional evidence that the A-1198B is a reliable, long-life design, and that the cast alumina layer is an effective insulator. Converter Serial No. 14 operated for 4470 hours at approximately 150 percent of the designed output power rating with a constant power output of 63 watts. Converter Serial No. 10 produced 76 watts (1.9 watts/cm^2) at an emitter temperature of 1360°C. Four improved Type A-1274A Modules, Serial Numbers 2 through 5, were fabricated. The improved reliability of the module was demonstrated in calibration tests of Module Serial No. 4, when more than 240 hours of operating time was accumulated over a wide range of operating conditions. Tests showed that although the A-1274A is capable of full design performance, additional collector cooling is required. Consequently, the radiation heat ejection system for Module Serial No. 5 was redesigned. Tests with the gas dosing injection system indicated that the need for more accurate gas injection, and the system was subsequently modified. Collectors of cesium fluoride, cesium sulfate, tungsten trioxide, iridium matrix, and palladium matrix were tested in Type A-1194E converters in the low-work-function collector investigation. Results were unsatisfactory, and additional experiments with cesium oxide, lithium oxide, and ruthenium collectors are planned. Data were compiled and analyzed on both molybdenum and niobium high-temperature collectors. The results showed that collectors can be operated as high as 700°C (with an emitter temperature of 1350°C) without inordinate loss of power. Higher collector temperatures require a compromise between power and weight. (auth)

18740 (PIBMRI-1224-64) DIRECT CONVERSION OF PLASMA KINETIC ENERGY TO R.F. ELECTROMAGNETIC ENERGY. Final Report. E. Levi, J. Freidberg, and M. Sandler (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Graduate Center). Aug. 1964. Contract AF30(602)-2980. 110p. (RADC-TDR-64-265; AD-605266). $4.00(CFSTI).

An outline of the guiding principles and the work accomplished during the twelve months of the contract is presented. This work produced a novel mathematical technique which makes it possible to follow the development with time of disturbances and the formation of shocks in magnetized plasmas, the discovery of hitherto unknown wave propagation modes which satisfy the two fluid nonlinear plasma dynamical equations, and the experimental detection of radiative modes in an impulsively excited toroidal discharge. (auth)

18741 (TE-41-65) THERMIONIC CONVERTER LIFE AND REPEATABILITY INVESTIGATION. C. Z. Kamien, J. H. Weinstein, and F. Rufeh (Thermo Electron Engineering Corp., Waltham, Mass.). Jan. 31, 1965. Contract AF33(615)-1348. 140p. (AFAPL-TR-65-7)

Life-test equipment has been designed and built to make possible testing of converters for long life as well as for cycling evaluation. Furthermore, diagnostic facilities are incorporated in the design of the life-test station. Life tests are in progress. The diagnostic facilities include equipment for the evaluation of gas evolution in the converters during life testing. In order to obtain significant data from the gas sampling effort, a technique has been developed to analyze the minute quantities of gas which may evolve in the course of diode operation. Results from the outgassing of one converter are presented. The results indicate that copper members of the converter require about three times the outgassing period of any other materials. The predominant gas was found to be hydrogen for copper and hydrogen and carbon monoxide in equal amounts for the emitter and collector. Design details and life-limiting characteristics of the converter are described. These converters employ rhenium emitters operating at a design temperature of 2000°K and a molybdenum collector at 940°K. The design incorporates a great amount of flexibility in the investigation of different components of the converter. The converter components can be re-

moved and replaced. Initial tests on the series 400 converters yielded an output of 30 watts at 0.7 volt (15 watts/cm^2) and 41.25 watts at 0.5 volt (20.6 watts/cm^2). Discussion of a thermionic scanner, its design details and its mode of operation are given. The data obtained by scanning a vapor-deposited rhenium-on-tungsten emitter are discussed. (auth)

18742 AN IONIZATION PROCESS IN A LOW-ENERGY CESIUM PLASMA. Harald L. Witting and Elias P. Gyftopoulos (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 36: 1328-37(Apr. 1965).

The mechanisms of ion formation in cesium plasmas at relatively low electron temperatures (3500°K) and pressures of a few torr are investigated. It is concluded that most of the ions are molecular and that they are formed by collisions between cesium atoms in the first excited state. The excited atoms are predominantly produced by inelastic electron collisions. The excitation cross section is computed by means of the impact parameter method. It has a maximum value of 100×10^{-16} cm^2 at 7 ev. The de-excitation cross section is computed and found to be approximately constant at 50×10^{-16} cm^2. Radiation trapping and diffusion of excited atoms are also studied. The ionization cross section is calculated by means of statistical thermodynamics from the measured recombination coefficient for the inverse of the ionizing process. It is found to be 1450×10^{-16} cm^2. The plasma is uniform throughout its volume except in the immediate vicinity of the bounding electrodes. The proposed mechanism results in performance characteristics for cesium thermionic converters, operating in the ignited mode, which are in qualitative and quantitative agreement with experimental data. (auth)

18743 ELECTRICAL PROPERTIES OF INERT GAS PLASMAS GENERATED IN THERMIONIC COLD-CATHODE DIODES BY RADIATION IN A NUCLEAR REACTOR. R. Forman (Union Carbide Corp., Parma, Ohio). J. Appl. Phys., 36: 1344-50(Apr. 1965).

The electric properties of inert gas (Xe, Kr, Ar) plasmas were studied in a nuclear reactor environment at gamma radiation dose rates up to 6×10^8 Rad/hr. The measurements are made by inserting a gas-filled thermionic diode into the core of a 5-Mw nuclear reactor. The space-charge neutralization effects caused by the ion-electron pairs generated in the gas are measured and interpreted in terms of plasma properties of the gas. The electric conductivity of the plasma, at a constant radiation level, goes through a maximum as a function of pressure in the range of 1–300 torr. If the radiation dosage is varied, keeping all other factors the same, one finds the electric conductivity monotonically increases with dose rate in the range of 10^6–6×10^8 Rad/hr. Experiments are described which indicate that electrons can be removed from a low work function cold electrode into the plasma by a mechanism different from either thermionic or field emission. A physical model is proposed to explain this phenomenon. (auth)

18744 PLASMA DIODES. Karl G. Hernqvist (RCA Labs., Princeton, N. J.). 7p. (CONF-776-5)

From National Electronics Conference, Chicago, Oct. 1964.

The operation and properties of a cesium diode in which the plasma is synthesized from electrons and ions emitted by two electrodes are described, and applications of these devices are discussed. (D.C.W.)

18745 SOLAR THERMIONIC GENERATORS FOR SPACE POWER. Pierre J. Brosens (Thermo Electron Engineering Corp., Waltham, Mass.). New York, American Society of Mechanical Engineers, 1964, Paper 64-WA/Sol-1, 9p. (CONF-763-50)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

An analysis is presented by which the relation between the size and design operating point of a thermionic generator and the available solar power can be obtained. (D.C.W.)

Elementary Particles and Radiations

Refer also to abstracts 17741, 18386, 18669, 19153, and 19161.

18746 (AD-423000) DECAY OF BOUND MUONS IN CARBON TETRACHLORIDE (thesis). Harold Eugene Wakitsch (Utah Univ., Salt Lake City. Dept. of Physics). Aug. 1963. 34p.

The percentages of decay of negative muons in chlorine and carbon were computed. Both positive and negative muon decays were recorded by the apparatus. These raw counts were converted to a rate curve that measured the total decay rate in counts/microsecond. A least-square analysis was applied to the rate equation. The results of this analysis showed that the percentage of negative muons that decay in the chlorine was 93 ± 8%. This result is in agreement with the "Z Law," which predicted that 92% of the negative muons decay in chlorine. (auth)

18747 (JINR-D-1925) A GALACTIC FIELD OF HYPERCHARGES AND THE K_2^1 DECAY INTO TWO PIONS. V. L. Lyuboshits, E. O. Okonov, and M. I. Podgoretskii (Podgoretsky) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1965. 11p. Dep.(mn).

Using the action by contact principle the main properties of the classical fields produced by the nonconserving charges were analyzed. It was shown that, despite the widely spread opinion, the introduction of such fields does not lead to a violation of the energy conservation law. It was also shown that the existence of the $K_2^1 \rightarrow \pi^+\pi^-$ decay which was recently observed experimentally cannot be quantitatively accounted for the action of the fields under discussion. (auth)

18748 (JINR-P-1941) RASSEYANIE SVETA NIZKOI CHASTOTY I POLYARIZUEMOST ZARYAZHENNOI CHASTITSY. (Scattering of Light of Low Frequency and the Charged Particle Polarizability). S. B. Gerasimov and L. D. Solovev (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 6p. Dep. (mn).

The cross section for the quasi-elastic scattering of photons of a low energy ω by a charged particle is considered, up to terms quadratic in ω and taking into account the radiative corrections. Among the quadratic terms the main ones, namely of the order $\omega^2 \ln \omega$, are found. Up to these terms the quasi-elastic scattering is determined, apart from the charge and mass of the particle, by the dynamic polarizability of the scatterer, which is proportional to $\ln \omega$. (auth)

18749 (JINR-P-1954) GRUPPA SIMMETRII SL(6) I RELYGTIVISTSKOE OBOBSHCHENIE GRUPPY SIMMETRII SU_6. (The Symmetry Group SL(6) and a Relativistic Generalization of the SU_6 Symmetry). Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 14p. Dep.(mn).

The symmetry of elementary particles which is based on the SL(6) group and is a relativistic generalization of SU_6 symmetry is treated. A generalized Dirac equation for the spinors of the SL(6) group is studied. The interaction lagrangian for the meson multiplet with the vector and axial currents was obtained. It is shown that this meson multiplet contains either a nonet of vector mesons and a nonet of pseudovector mesons, or a nonet of vector mesons and an octet of pseudoscalar mesons. In the latter case the interaction between axial currents and pseudoscalar mesons is an interaction involving a derivative. (auth)

18750 (NP-14817) A STUDY OF THE REACTION $p + p \rightarrow d + \pi^+$ FROM 1 TO 2.8 Bev. Technical Report No. 18. Richard M. Heinz (Michigan Univ., Ann Arbor. Dept. of Physics). Oct. 1964. Contract Nonr-1224(23). 79p.

The differential and total cross sections have been measured with scintillation counters for incident proton kinetic

energies of 1.0, 1.3, 1.5, 1.7, 2.0, 2.5, and 2.8 Bev. Values of the differential cross section are given for barycentric deuteron angles, θ, for $0 \geq \cos\theta \geq -.97$ in small intervals of $\cos\theta$. From 1.3 to 2.0 Bev, as $\cos\theta$ varies from −0.5 to −1.0, the differential cross section rises, passes through a pronounced maximum, and then decreases rapidly. This maximum propagates from $\cos\theta = -0.8$ at 1.3 Bev to $\cos\theta = -.94$ at 2.0 Bev, and evolves into a sharp peak at $\cos\theta = -1.0$ for energies above 2.0 Bev. The total cross section decreases rapidly and monotonically with energy from 450 μb at 1.0 Bev to 30 μb at 2.8 Bev. A theoretical calculation is made using the one-nucleon exchange peripheral model, and the data are compared with this and with the one-pion exchange model and the statistical model. The only theoretical success is obtained with the one-nucleon exchange model, which qualitatively explains the observed angular distributions of the differential cross section above 1.0 Bev in terms of the strong repulsive core in the nucleon-nucleon central interaction potential; the model also shows that the rapid decrease of the total cross section with energy is expected because of the structure of the deuteron momentum-space wave function. (auth)

18751 (ORNL-3734) NUCLEON-MESON CASCADE CALCULATIONS: TRANSVERSE SHIELDING FOR A 45-Gev ELECTRON ACCELERATOR. PART IV. R. G. Alsmiller, Jr., F. S. Alsmiller, and J. Barish (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 15p. Dep.; $1.00(cy), 1(mn) CFSTI.

In a series of previous reports nucleon–meson cascade calculations were described for several cases of interest in the design of the transverse shield for the proposed 45-Bev linear electron accelerator at Stanford University. A recalculation using an improved IBM code of one of the cases previously treated is described. There are numerical differences between the present and previous results but the total dose estimates obtained from the two calculations are essentially the same. (auth)

18752 (UCRL-2426(Vol. I)(1965 Rev.) HIGH-ENERGY PARTICLE DATA. VOLUME I. KINEMATICS OF PARTICLES AS A FUNCTION OF KINETIC ENERGY. W. Peter Trower, Beverly Hill Willis, and Charles V. Stableford (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 1965. Contract W-7405-eng-48. 125p. Dep.; $4.00 (cy), 3(mn) CFSTI.

Revised high-energy particle date graphs are given (see also orginal UCRL-2426, NSA 11: 6867 and UCRL-2426 (Vol. I)(1963 Rev.) NSA 18: 28331). The ellipse-plotting method for solution of the relativistic two-body problem is discussed. Graphs for the kinematics of elementary particles and dynamics of collisions with a proton target are presented. A mnemonic device for relativistic kinetic formulas, rules for relativistic kinematics, and the solid angle subtended by a finite rectangular counter are discussed. (C.E.S.)

18753 (UCRL-11877) MEASUREMENT OF THE SPIN-CORRELATION PARAMETER C_{NN} IN PROTON-PROTON SCATTERING AT 680 Mev (thesis). Helmut Ernst Dost (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 5, 1965. Contract W-7405-eng-48. 98p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Using a polarized beam and polarized target, the spin-correlation parameter C_{NN} in proton-proton scattering is measured for an incident-proton laboratory-system kinetic energy of 680 Mev. The polarized beam was made by scattering unpolarized protons from the 184-in. cyclotron in an external first target of liquid hydrogen, resulting in a polarization of 0.44. To reverse the beam polarization, the incident-proton scattering angle was reversed. The target protons were polarized by dynamic polarization to 0.40 on the average. The elastic proton-proton interactions involving the polarized protons were kinematically separated from other interactions by counting both protons in coincidence. The angular region covered by the data extends from 51.2 to 88.7° in the center-of-mass system. The results show that C_{NN} rises in this region from about 0.5 to 0.9 with a typical standard deviation of 0.1. (auth)

18754 (UCRL-12344) EFFECT OF AN INELASTIC CHANNEL ON THE POSITION AND WIDTH OF A RESONANCE. M. DerSarkissian (Lawrence Radiation Lab., Univ. of California, Livermore) and Pran Nath (California Univ., Riverside. Dept. of Physics). Jan. 15, 1965. Contract W-7405-eng-48. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A simple model is constructed to study the effect of adding one extra channel in an N/D calculation of the position and width of a resonance. It is found that the mass of the resonance is shifted toward threshold. This means the effect of the extra channel is always to add an attractive force. The situation with regard to the width is ambiguous and requires more detailed numerical calculations. (auth)

18755 (UR-875-28) BOUNDARY CONDITION MODEL. II. ANTIHYPERON-NUCLEON SCATTERING. Martin S. Spergel (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Mar. 27, 1964. Contract AT(30-1)-875. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The differential elastic, total elastic, charge exchange, and annihilation cross sections and polarization have been calculated up to several hundred Mev for antihyperon-nucleon scattering. Cross sections have also been calculated for $\bar{\Lambda}N \to \bar{\Sigma}N$. The model employed for the calculation utilizes an "elastic" one- and two-pion potential plus an absorptive-core boundary condition. The "elastic" antihyperon-nucleon potential is constructed using SU_3 group symmetries. (auth)

18756 (JPRS-28496(p.32-7)) ON SEVERAL PROBABLY EXISTING RESONANCE STATES: 625 Mev AND 1000 Mev OF THREE-PION, AND 1050 Mev OF FOUR-PION. Ch'ung-Shou Kao. Translated from K'o Hsueh T'ung Pao, No. 11, 1001-3(Nov. 1964).

Two resonance states in the 3-pion series are discussed. They are the α resonance of mass $M = 625 \pm 25$ Mev and width $\Gamma = 100$ Mev and the so-called β resonance with $M = 1000 \pm 10$ Mev and $\Gamma = 120 \pm 40$ Mev. A 4-pion resonance at ~1050 Mev is also discussed. Probable quantum numbers and decay properties are considered. (C.E.S.)

18757 COMPLEMENTARITY BETWEEN REGGE TRAJECTORIES AND UNITARY SYMMETRY SCHEMES. Muhammad Jameel (Atomic Energy Centre, Lahore). Acta Phys. Polon., 26: 1021(Nov. 1964).

The complementary nature of the Regge trajectory and unitary symmetry schemes is demonstrated on the basis of a rather natural classification of particle quantum numbers. (D.C.W.)

18758 UNITARY SYMMETRY AND $\Delta T = \frac{1}{2}$ RULE. W. Krolikowski (Inst. for Nuclear Research, Warsaw and Univ. of Warsaw). Acta Phys. Polon., 26: 1163-8(Dec. 1964).

It is proved that the $\Delta T = \frac{1}{2}$ rule of non-leptonic weak interactions follows from the unitary structure of baryons and mesons, if in the mixing of fields caused by weak interactions the indices α and β of the 3×3 matrices describing baryons and mesons mix separately in the first order. (auth)

18759 REMARK ON THE TWO-CENTER MODEL IN THE ACCELERATOR ENERGY RANGE. Kacper Zalewski (Inst. of Physical Chemistry, Krakow). Acta Phys. Polon., 26: 1169-73(Dec. 1964).

The intermediate state amplitude is assumed to be of the form $\Sigma_{l=0}^{L} a_l P_l(\cos\theta)$, where θ is the center of mass scattering angle. The maximum of $(\cos\theta)_{average}$ is found as a function of L. (auth)

18760 ANALYTICAL PROPERTIES OF TWO-CHANNEL S-MATRIX. Masaaki Kato (Univ. of Wisconsin, Madison). Ann. Phys. (N. Y.), 31: 130-47(Jan. 1965).

It is shown that four Riemann sheets of the two-channel S-matrix can be mapped onto a single plane by a conformal transformation. On this plane the S-matrix gets rid of the right-hand cuts and is expressed in terms of poles and zeroes as well as the unphysical singularities. The LeCouteur-Newton relation for multichannel S-matrices together with unitarity imposes restrictions on the positions of poles and zeroes. As applications, the behavior of the S-matrix

near an inelastic threshold and a generalization of Levinson's theorem to two channel reactions are considered. (auth)

18761 AMBIGUITIES IN THE DETERMINATION OF THE S-MATRIX FROM ELASTIC SCATTERING EXPERIMENTS. R. van Wageningen (State Univ., Groningen, Netherlands). Ann. Phys. (N. Y.), 31: 148-84(Jan. 1965).

The possibility that the S-matrix can not be unambigously determined from scattering experiments is investigated. It is shown that the helicity formalism of Jacob and Wick is suited to treat this question. A derivation of this formalism from the channel spin formalism of Blatt and Biedenharn is given, using only elementary methods. The derivation and description of ambiguities of a certain type, so-called torsions, are then presented. The possibility of a physical interpretation of these torsions is discussed. The cases of spin $\frac{1}{2}$-spin 0, spin 1-spin 0, spin $\frac{3}{2}$-spin 0, and spin $\frac{1}{2}$-spin $\frac{1}{2}$ scattering are explicitly treated. In particular nucleon-nucleon scattering with charge-independent interaction is considered. (auth)

18762 ELEMENTARY PARTICLES AS ELEMENTARY PARTICLES. C. R. Hagen (Univ. of Rochester, N. Y.). Ann. Phys. (N. Y.), 31: 185-202(Jan. 1965). (UR-875-33)

The Z = 0 rule is investigated within a general field theoretic formulation. It is shown that the equivalence of a system with an elementary particle of vanishing wave function renormalization to a direct interaction theory is intimately related to the divergence of the bare mass and the consequent degeneration of the equations of motion. The results obtained are fully illustrated in terms of appropriately generalized versions of Zachariasen's model. It is argued that any field theoretic approach which treats all particles as being equally elementary is subject to severe criticism and can derive no support whatever from the Z = 0 rule. (auth)

18763 STRUCTURE OF THE PROTON. Robert R. Wilson and Joseph S. Levinger (Cornell Univ., Ithaca, N. Y.). Ann. Rev. Nucl. Sci., 14: 135-74(1964).

A review is given of studies of proton structure, with discussions of heavy mesonic states and electron-proton scattering, and the agreement between current models and measurements is examined. The Rosenbluth formula for e-p scattering is presented. Previous measurements of proton and neutron form factors are described, and the results are tabulated. The validity of the Rosenbluth formula for two-photon processes and of the laws of quantum electrodynamics for photons, electron, and muons is discussed. The use of inelastic e-N scattering for form-factor studies is mentioned. 88 references. (M.J.T.)

18764 THE MOTION OF AN ELECTRIFIED PARTICLE IN A MAGNETIC FIELD VARIABLE WITH TIME. Maria Teresa Vacca. Atti Accad. Sci. Torino. I. Classe Sci. Fis., Mat. Nat., 98: 1153-60(1963-64). (In Italian)

The equations of motion of an electrically charged particle in a magnetic field uniform in space, but variable with time, are considered; and the existence, in the plane case, of a prime integral which is a generalization of the integral of area is shown. An approximate solution of the equations of motion is then obtained under the hypothesis that the magnetic field varies slowly with time. (tr-auth)

18765 PHENOMENOLOGICAL ANALYSIS OF POLARIZATION OF ELECTRONS IN NEUTRON BETA DECAY. M. Kozlowski (Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys., 12: 663-8(1964).

The longitudinal polarization of electrons in neutron beta decay is obtained. Following the methods recently developed by Jacob, Wick, and Werle for many-particle reactions, the matrix elements of the T matrix for beta decay are treated as unknown coefficients in a partial-wave expansion. Assuming localized weak interaction and anticommutation of the leptonic part of the T matrix ($T^{\mu}_{(lep)}$) with γ_5, the same result as that obtained by conventional approach based on the theory of universal four-fermion interaction is obtained. (auth)

18766 ANGULAR DISTRIBUTIONS OF THE DECAY PION OF THE ISOBAR PRODUCED IN THE PION-PROTON INTERACTION. William Laskar (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., 259: 4528-30 (Dec. 21, 1964). (In French)

If $\vec{l}$ is the angular momentum of the incident $\pi(\pi_1)$ and $\vec{L}$ that of the π associated with the isobar (π_0), for the total angular momentum $\vec{J}$ of the system, one will have $\vec{J} = \vec{l} + \vec{1/2} = \vec{L} + \vec{3/2}$, because of the conservation of the angular momentum. The distributions of the decay π of the isobar (π_d) will depend on L. A study is made of this dependence. (tr-auth)

18767 ANGULAR EFFECTS IN THE DECAY OF THE NUCLEONIC ISOBAR N_{33}. Georges Valladas (Centre d' Etudes Nucleaire, Saclay, France). Compt. Rend., 259: 4531-3(Dec. 21, 1964). (In French)

An expression is given for the angular distribution of the decay pion of the isobar N_{33}. It is applied to the study of the left-right asymmetry of this distribution. (tr-auth)

18768 FUSION OF TWO SPIN-½ PARTICLES WITH GIVEN INTRINSIC MASSES. Thiounn Mumm. Compt. Rend., 260: 442-4(Jan. 11, 1965). (In French)

The expressions describing the fusion of two spin-½ particles of any intrinsic mass are derived. (J.S.R.)

18769 ELASTIC SCATTERING OF NEUTRINOS AND THE STRUCTURE OF THE PHOTON. Bernard Jouvet (College de France, Paris). Compt. Rend., 260: 449-52 (Jan. 11, 1965). (In French)

By acceptance of the hypothesis of the universal current-current interaction, it is shown that the measurement of the elastic interactions of neutrinos makes possible the determination of whether the photon is a compound particle. It can indicate the existence of leptons other than e and μ. It will furnish either the indication of an abnormal interaction of the μ or essential information for the calculation of the constant Z_3 of the photon. (tr-auth)

18770 DISTRIBUTION OF TRANVERSE MOMENTA IN MESON JETS AT ACCELERATOR ENERGIES. E. M. Friedlaender. Comun. Acad. Rep. Populare Romine, 13: 811-15(1963). (In Rumanian)

It is shown that momentum conservation entails a strong decrease of the average transverse momentum at low emission angles. Various consequences of this decrease are discussed. (auth)

18771 AN ANTIPROTON EVENT. G. C. Deka (Cotton Coll., Gauhati, India) and T. D. Goswami, Indian J. Phys., 38: 409-12(Aug. 1964).

During the systematic scanning for double stars in nuclear emulsions exposed to a 3-Bev. pion beam, an event was recorded, which from analysis, can be interpreted as due to the annihilation of an antiproton produced in the emulsion. The details of the event along with a microphotograph are given. (auth)

18772 ELASTIC p-d SCATTERING AT SMALL ANGLES AT 6.2 Gev. Z. M. Zlatanov, C. M. Kanazirski, P. K. Markov, and L. G. Christov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 11: 101-4(1963). (In Russian)

The photoemulsion technique was used to study elastic p-d scattering at 6.2 Bev. A stack of 29 emulsion pellicles, inflated with heavy water, was exposed to the internal proton beam of Dubna synchrophasotron. The incident beam was perpendicular to the pellicle surface and had a density of $4.13 \pm 0.08 \times 10^5$ protons/cm^2. A total of 140 events was found. The differential cross section is shown. The elastic cross section in the region from 1.5 to 7.5° in the center of mass system was found to be 8.41 ± 0.73 mb/sterad. The screening coefficient of the deuteron was found to be 9%. (auth)

18773 ELASTIC p-p SCATTERING AT 6.2 Gev. A. J. Zlateva, P. K. Markov, and C. M. Chernev. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 11: 105-20(1963). (In Russian)

The elastic p-p interaction was investigated by exposing emulsion stacks to a 6.2-Bev proton beam. A total of 325 elastic events were identified, and the differential cross sections were obtained for several regions of small angles in the center of mass system. The differential cross section was obtained as a function of the square of four-

momentum transfer by combining the present results with results obtained elsewhere. (D.C.W.)

18774 ELASTIC π^--p SCATTERING AT 4 Gev/c. A. Zlateva, P. Markov, T. Todorov, and Ch. Tchernev. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 12: 77-91(1964). (In Russian)

The elastic meson (π^-)-proton interaction was investigated by exposing emulsion stacks to a meson (π^-) beam. The differential cross sections were calculated, using 115 elastic events observed elsewhere together with the present results. The elastic cross section for angles of 3 to 15° in the center of mass system was found to be 2.8 ± 0.3 mb. The data were fitted to a two-parameter curve. Within the limits of error, the experimental data were in agreement with the prediction of the optical theorem for the forward scattering amplitude. (D.C.W.)

18775 ON SOME QUESTIONS CONNECTED WITH THE ALGEBRAISATION OF THE EQUATIONS OF PION-NUCLEON AND PION-PION SCATTERING. I. Nedyalkov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 11: 121-37(1963). (In Russian)

Using the principles of analysis, cross-symmetry, and unitarity, an algebraic system is presented for the description of certain processes of scattering in pion-nucleon and pion-pion scattering. This system is found to be sufficiently simple for calculations and might also be used to explain certain properties of the solutions. (auth)

18776 ON A CONSEQUENCE OF THE LORENTZ-INVARIANCE OF NEUTRINO EQUATION OF MOTION. D. Fakirov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 12: 245-9(1964). (In Bulgarian)

It is shown that in order to obtain the correct relations between $a_{\mu\nu}$, Σ_μ, and Λ it is necessary to use not only the wave function for the two component neutrino and the Hermitian of the reduced wave function but also the invariant relation $\partial/\partial\chi_\mu\,(\varphi + \Sigma_\mu\varphi) = 0$. This procedure is required only for the neutrino with zero mass. (M.J.T.)

18777 CALCULATION OF ELECTRON BEAM INTERACTION WITH TRAVELING WAVE FIELD IN CROSS FIELDS AT FINITE DIMENSIONS OF INTERACTION SPACE. M. N. Kulikov and V. S. Stal'makhov (Saratov State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 1002-4(1964). (In Russian)

The field theory in linear approximation was used to analyze the interaction of beams of finite thickness, having low space-charge density with the field of the decelerating system, taking into account the finite dimensions of the space in which the interaction occurs. This method yields more strictly valid results than calculations based on the determination of the perturbation of the field of the decelerating system by high-frequency beams. The derived correlation is considered to be more generally valid than similar derivations given in the literature. It takes into account the thickness of the beam and its position in the space in which the interaction occurs, making it possible to determine the initial amplitude of the partial waves which is needed for the design of the experimental equipment. The four coefficients required for these calculations may be determined easily. The operational characteristics of multicascade-type devices were successfully analyzed by this method. (TTT)

18778 ONWARD FROM THE Ω^-. P. T. Matthews (London Univ.). New Scientist, 24: 888-90(Dec. 31, 1964).

The verification of the SU(3) symmetry for strong interactions by the observation of the hyperon (Ω^-) is discussed, together with the extension from SU(3) to SU(6). The breakdown of CP invariance for weak interactions is also considered. (D.C.W.)

18779 CONTRIBUTIONS OF ANOMALOUS SINGULARITIES IN ELASTIC K-D SCATTERING. D. Rebel (Humboldt Universitat, Berlin). Nucl. Phys., 66: 577-94(May 1965).

The contributions of the lowest intermediate states $|\Lambda,N\rangle$ and $|\Sigma,N\rangle$ to the scattering amplitude for elastic K-D forward scattering are investigated in the framework of dispersion theory. The analytic continuation of these contributions with respect to the K-meson mass is explicitly performed by making use of the impulse approximation for the $\bar{K}$-D absorptive process $K + D \rightarrow Y + N$. It turns out that in the unphysical region in addition to anomalous logarithmic branch cuts anomalous poles play an important role. A numerical estimation of the different contributions due to the intermediate states considered shows that the anomalous pole contributions are large if compared to the respective continuous contributions. If the latter are separately analyzed the anomalous continuous contributions dominate the normal ones. The dispersion relation for the elastic K-D forward scattering considered is compared with the corresponding relations for the scattering on free nucleons. (auth)

18780 ISOBAR PRODUCTION IN NUCLEON-NUCLEON COLLISIONS. II. POLARIZATION EFFECTS. Alladi Ramakrishnan, K. Raman, and R. K. Umerjee (MATSCIENCE, Inst. of Mathematical Sciences, Madras). Nucl. Phys., 66: 609-31(May 1965).

Some of the polarization effects are studied for the process of single-isobar production in nucleon-nucleon collisions in a model in which the production amplitude is approximated by the pole contributions. Only those effects are studied which do not involve the isobar polarization and which involve the polarization of only two of the nucleons – either the two initial nucleons or an initial nucleon and the recoil nucleon; this is done using covariant projection operators. The most general dependence of the differential cross section on the polarizations is derived, and the six polarization correlation functions are defined and evaluated as functions of the scattering angle; numerical results are obtained for π and ρ exchange. The type of information that can be obtained from the polarization correlations is discussed. (auth)

18781 REDUCIBILITY OF PARASTATISTICS REPRESENTATIONS. A. Casher, G. Frieder, M. Glueck, and A. Peres (Israel Inst. of Tech., Haifa). Nucl. Phys., 66: 632-4(May 1965).

Assuming that the physical properties of a system of n identical particles are not affected by the possible existence of further particles of the same species (e.g. on another planet), it is shown that the only irreducible representations of the permutation group of these n particles are those corresponding to Bose-Einstein or Fermi-Dirac statistics. (auth)

18782 ON THE $J = 0^+$, $T = {}^1/_2$ Kπ RESONANCE. M. Noga and J. Pisut (Comenius Univ., Bratislava). Nucl. Phys., 66: 635-7(May 1965).

An attempt is made to explain the resonance with quantum numbers $B = 0$, $J = 0^+$, $S = 1$, $T = {}^1/_2$ as a dynamical resonance in the Kπ system. (auth)

18783 ASYMPTOTIC BEHAVIOR OF MANY-POINT AMPLITUDES IN LADDER APPROXIMATION. Y. A. Simonov and K. A. Ter-Martirosyan (Inst. of Theoretical and Experimental Physics, Moscow). Nucl. Phys., 66: 641-8(May 1965).

The asymptotic behavior of the amplitude of an inelastic process of the type $1 + 2 \rightarrow 3 + 4 + 5$ is studied using the ladder approximation as an example. Two major cases are considered: the total energies in the c.m. system of particles 3, 4 and particles 4, 5 tend to infinity together with the energy of the incident particles (the case of essentially inelastic collisions) and the total energy of one pair (3 and 4, or 4 and 5) tends to infinity while the energy of the other pair remains constant (the case of quasi-elastic collisions). The asymptotic behavior in these cases coincides with that obtained by the method of complex angular momenta. (auth)

18784 MUON LIFETIME AND INTEGRAL SPECTRUM. J. Niederle (Inst. of Physics, Prague) and J. Ulehla. Nucl. Phys., 66: 649-52(May 1965).

The muon lifetime and integral spectrum for the muon decay was calculated including electromagnetic corrections to the order e^2g^2 in V-A theory. (auth)

18785 IS THE PARITY OF THE K^0 MESON IMAGINARY? A PROPOSED ANALYSIS OF $K_1^0 - K_2^0$ MASS-

DIFFERENCE EXPERIMENTS. Alan Natapoff (Univ. of California, Berkeley). Nucl. Phys., 66: 653-6(May 1965). (UCRL-11507)

As postulated by Spitzer, the K^0 meson has well-defined the imaginary parity relative to the vacuum. Further, electromagnetic transitions could carry K^0 into $\overline{K}^0$ in the presence of an external field. A search, by analyzing existing experimental results, for the implied dependence of the $K_1^0 - K_2^0$ mass difference on the external field is proposed and discussed. (auth)

18786 MULTIPLE SCATTERING ANALYSIS OF K^--d INTERACTIONS. N. M. Queen (Univ. of Birmingham, Eng.). Nucl. Phys., 66: 673-87(May 1965).

Corrections to the impulse approximation for K^- meson scattering by the deuteron are studied. Certain multiple scattering contributions are summed exactly to all orders and are shown to give unitarity corrections to the single scattering approximation. The formalism is applied to calculations of the elastic and total cross sections for K^--d interactions at low energies, using six sets of $\overline{K}N$ scattering parameters given by Chand. The accuracy of the results and their relation to those of previous models are discussed. It is found that the K^--d cross sections considered cannot serve to distinguish between the various sets of $\overline{K}N$ parameters which fit the available K^--p data. (auth)

18787 AN APPROACH TO THE PROBLEM OF BOUND STATES. [PART] II. T. Maekawa (Kumamoto Univ., Japan). Nuovo Cimento (10), 35: 419-33(Jan. 16, 1965).

The previous method is applied to the cases of the scalar and pseudoscalar four-Fermion interactions. The integral equations for the particle-antiparticle two-body bound system are derived and then analyzed in terms of partial waves. In the special case of contact interaction, the possible bound states are $^1S_0$, $^1P_1$, $^3P_0$, $^3P_1$, and $^3S_1 + {}^3D_1$ for both scalar and pseudoscalar interactions, and numerical solutions are obtained for each of these states. The $^3S_1 + {}^3D_1$ solution for the pseudoscalar interaction has an unfamiliar feature as appeared in the case of the vector interaction, but no such solution exists in the case of the scalar interaction. (auth)

18788 FINAL-STATE INTERACTIONS AMONG THREE PARTICLES. I. J. R. Aitchison (Centre d'Etudes Nucleaires, Saclay, France and Service de Physique Theorique, Gif-sur-Yvette, France). Nuovo Cimento (10), 35: 434-59(Jan. 16, 1965).

A review is given of some recent approaches to the problem of final-state interactions among three particles, via dispersion and perturbation theory. The connection between the two methods is emphasized, but no essentially new result is presented. Attention is then focused on the first rescattering correction to the Watson formula, and a simple approximation is suggested for it, and shown to be remarkably good numerically. Further, this approximation is shown to provide a connection between the models of dispersion (or perturbation) theory and potential theory. For the nucleon-deuteron break-up reaction it corresponds exactly, in the nonrelativistic limit, to the first rescattering correction to the impulse approximation, in the case of zero-range forces. (auth)

18789 COUPLING CONSTANTS IN BROKEN UNITARY SYMMETRY. B. Diu, H. R. Rubinstein, and J. L. Basdevant (Universite de Paris, Orsay, France). Nuovo Cimento (10), 35: 460-71(Jan. 16, 1965).

A set of Yukawn coupling constants needed in analytic calculations of pseudoscalar meson-baryon amplitudes (including exchange of resonances, vector mesons and baryons) is presented. Since, in such calculations, the existence of poles is very sensitive to the values of the crossed-channel couplings, one needs to improve on exact unitary symmetry predictions, which, as is well known, give inaccurate ratios for a number of already known parameters (e.g. $g_{K^*K\pi}/g_{\rho\pi\pi}$, $g_{Y_1^*\pi\Lambda}/g_{Y_1^*\pi\Sigma}$ and $g_{\Xi^*\pi\Xi}/g_{\Delta^*\pi\pi}$). The coupling constants are here calculated by taking into account first-order SU_3 violations, as already suggested by Muraskin and Glashow. The universality conditions of Sakurai are imposed on vector-meson couplings, which drastically reduce the number of parameters. The results are compared with the scanty experimental data, which, however, can provide tests of the first-order violation hypothesis. (auth)

18790 REGGE-POLES AND REACTION CROSS-SECTIONS FOR PARTICLES WITH SPIN. E. O. Fiset (Univ. of Washington, Seattle). Nuovo Cimento (10), 35: 472-83 (Jan. 16, 1965). (TID-20845)

The Jacob and Wick theory of collisions for particles with spin is Reggeized to yield a single-pole expression for differential cross sections for two-particle reactions. This expression is valid for particles with any spin. The particular examples of $\pi N \to \rho N$ and $\pi N \to \omega N_{33}$ are worked out. The procedure for passing to the high-energy limit is demonstrated for the first example. (auth)

18791 SYMPLECTIC SYMMETRY OF HADRONS. H. Bacry, J. Nuyts, and L. Van Hove (CERN, Geneva). Nuovo Cimento (10), 35: 510-33(Jan. 16, 1965).

A model is proposed for SU_3 symmetry in which the known SU_3 multiplets of hadrons (strongly interacting particles) are considered as bound states of basic particles t of spin $\frac{1}{2}$, baryon number 1, and electric charge 0, ±1, and of their antiparticles $\bar{t}$. These basic particles form SU_3 triplets and are regarded to be heavy compared to the proton mass. The known meson octets and singlet are supposed to result from binding of a t and a $\bar{t}$, giving in terms of SU_3 symmetry the structure $\bar{3} \times 3 = 1 + 8$. The baryon octet, decuplet (and possibly singlet) are given the composition $\bar{t}tt$, with the SU_3 structure $3 \times 3 \times 3 = 1 + 8 + 8 + 10$. These requirements, and the condition to minimize the number of basic particles, lead uniquely to the introduction of 6 basic particles t, one 3 triplet of charges +, 0, 0 and one $\bar{3}$ triplet of charges 0, +, +. They are associated with the values $\frac{1}{3}$ and $-\frac{1}{3}$ of a new quantum number Z. For the known particles Z is equal to the baryon number. One then introduces a higher-symmetry group incorporating the new quantum number as well as SU_3. This is done within the framework of simple Lie groups, and one is led to select the symplectic group in six dimensions Sp_6, whose lowest dimensional representation exactly accommodates the six basic particles t. With this higher symmetry the model predicts an SU_3 triplet of new pseudoscalar mesons, an SU_3 sextet of new vector mesons, as well as their antiparticles, with mass separations calculable from the masses of the known mesons. For the known pseudoscalar mesons and baryons one finds the usual Gell-Mann-Okubo mass formulas, whereas for the known vector mesons one derives a mass relation identical to the formula obtained in Schwinger's W_3 symmetry model. The model predicts in addition many new baryon resonances of high mass and large width. All mass predictions are obtained by taking a mass splitting operator of form $\Delta m_1 + \Delta m_2$, where Δm_1 breaks Sp_6 symmetry but preserves SU_3, while Δm_2 breaks SU_3. Δm_1 is regarded as larger than Δm_2 and is taken to second order, while for Δm_2 only first-order effects are included. One is led to this assumption of a symmetry violation which is larger for Sp_6 than for SU_3 by the circumstance that the first-order mass-splitting effects leave the new mesons to be degenerate in mass with the known ones, a situation which is unattractive in several respects. (auth)

18792 THE ONE-PARTICLE-EXCHANGE APPROXIMATION AND FEYNMAN GRAPHS. B. Diu (Universite de Paris, Orsay, France) and J.-L. Gervais. Nuovo Cimento (10), 35: 534-44(Jan. 16, 1965).

It is shown, in a scalar model, that the one-particle-exchange approximation with elastic unitarity on the right-hand cut is not equivalent to summing a series of Feynman graphs. The convergence properties of the N/D integrals are studied in the case of vector-meson exchange between two spinless particles: it appears that, although the interaction is not renormalizable, a single subtraction is sufficient to give finite results at any order in the coupling constant. (auth)

18793 THE PHOTON-POLE APPROXIMATION IN PAIR PRODUCTION PROCESSES. V. Gorge (Universitat, Bern). Nuovo Cimento (10), 35: 545-69(Jan. 16, 1965).

A covariant form of the Weizsäcker-Williams approximation is discussed in two examples of positron-electron pair production processes: the photo-pair production in the field of the electron (without taking into account the exclusion principle), and pair production in the scattering of two charged particles. The approximation procedure is compared with the lowest-order results of quantum electrodynamics, and arguments for the applicability and the limitations of this approximation are given. Various numerical results are presented for the photo-pair production cross section and for pair production corrections to the elastic μ-e scattering cross section at 8 Bev. (auth)

18794 PERATIZATION OF SPINOR GREEN'S FUNCTIONS. F. T. Hadjioannou (Nuclear Center "Democritus" and Center for Advanced Study in Physics Aghia Paraskevi, Athens). Nuovo Cimento (10), 35: 570-81(Jan. 16, 1965).

The spinor two-point Green's functions are calculated in ladder approximation and with an interaction Lagrangian: vector coupling of the spinor to a massive vector boson, V-A interaction of the spinor to a charged massive boson (W). It is found (in the ladder approximation) that although the interaction is nonrenormalizable in the conventional sense, through a mechanism of self-damping the Green's functions become finite. Indeed the calculated functions have an essential singularity at infinity but as the invariant mass square goes to infinity in the physical sheet the Green's functions vanish. The calculation is suggestive that the mechanism of self-damping acting as a natural cutoff might lead to finite results for nonrenormalizable theories. (auth)

18795 AN SU_4 UNIFIED SCHEME FOR WEAK INTERACTIONS. N. Dallaporta and T. Toyoda (Universita, Padua). Nuovo Cimento (10), 35: 586-98(Jan. 16, 1965).

In order to unify the treatment of the purely leptonic interactions and of the leptonic decays of baryons, a general scheme is proposed including into a single isobaric state of the regular representation of SU_4 all weakly interacting fermions, both baryons and leptons. The definition of the charge operator in SU_4 as an extension of the usual one in SU_3 is discussed in order to obtain the best agreement with the known particles. For what concerns the interaction it is then shown that, in order to agree with the experimental evidence, one has from one side to reduce the symmetry to that of the subgroup SU_2 and from the other side, to rotate the strongly interacting baryonic states in respect to the weakly interacting ones according to the Cabibbo transformation. The scheme is thus able to yield in a unified way results similar to Gatto's theory for leptons and to Cabibbo's theory for leptonic decays of baryons. (auth)

18796 ON THE THEORY OF SCATTERING BY SINGULAR POTENTIALS. L. Bertocchi (Universita, Bologna), S. Fubini, and G. Furlan. Nuovo Cimento (10), 35: 633-43 (Jan. 16, 1965).

Some characteristic features of the scattering by singular potentials are investigated both in the low- and the high-energy limit. (auth)

18797 RESTRICTIONS ON COUPLING CONSTANTS IN A BOOTSTRAP MODEL OF VECTOR MESONS. H. Banerjee and V. S. Mathur (Univ. of Delhi). Nuovo Cimento (10), 35: 651-4(Jan. 16, 1965).

It is pointed out that elastic unitarity and analyticity properties impose severe restrictions on the vector-pseudoscalar meson coupling constants. The problem of bootstrapping the meson (ρ) in π-π scattering is considered. The restriction imposed on the $\rho\pi\pi$ coupling constant does not improve even if one goes beyond the one-channel approximation. These results can be extended to cover the general problem of bootstrapping the vector octet. (C.E.S.)

18798 POSSIBLE METHOD FOR MEASURING THE $\eta^0 \rightarrow \gamma + \gamma$ DECAY RATE. Chai Shing Lai (Univ. of Chicago). Nuovo Cimento (10), 35: 655-8(Jan. 16, 1965). (COO-264-218)

It is proposed, for the determination of the $\eta^0 \rightarrow \gamma + \gamma$ partial width, the reaction $\gamma + p \rightarrow p + \eta^0$, which is assumed to occur via one meson (ρ) exchange, if the coupling constant $f_{\eta\rho\gamma}$ is assumed to exist. In this peripheral model of the production of the meson (η) it is plausible that the virtual meson (ρ) would be absorbed immediately by the protons without having the time to decay into a virtual photon. The reaction would then be enhanced by about 10^4 times over that of the purely electromagnetic one. (C.E.S.)

18799 EXCHANGE MECHANISMS FOR THE REACTIONS $\pi^+ p \rightarrow \Delta^{*++}\rho^0$ AND $\pi^+ p \rightarrow \Delta^{*++}\omega^0$ AT 4 Gev/c. M. Aderholz (Technische Hochschule, Aachen), L. Bondar, M. Deutschmann, et al. Nuovo Cimento (10), 35: 659-63 (Jan. 16, 1965).

The Gottfried-Jackson analysis was applied to the reactions $\pi^+p \rightarrow N^{*2+}\rho^0$ and $\pi^+p \rightarrow N^{*2+}\omega^0$ in an attempt to determine the exchange mechanism in events of the type $\pi^+p \rightarrow p\pi^+\pi^+\pi^-$ observed in the hydrogen bubble chamber. Meson (π), (η), (ω), and (ρ) exchange were considered. (C.E.S.)

18800 UNIVERSAL EQUAL-SPACING MASS FORMULA. T. Takabayasi (Nagoya Univ., Japan). Nuovo Cimento (10), 35: 666-71(Jan. 16, 1965).

The equal-spacing relations among strongly interacting particle masses are investigated in an attempt to unify them into a single universal scheme that gives all baryonic and mesonic mass levels including recently observed resonances. (C.E.S.)

18801 A $\pi\Sigma$ RESONANCE WITH I = 2 AND UNITARY SYMMETRY. S. Minami (Osaka City Univ.). Nuovo Cimento (10), 35: 672-3(Jan. 16, 1965).

Previous experimental data for the $\pi^-\Sigma^-$ mass plot in the reaction $K^- + n(C) \rightarrow \Sigma^- + \pi^- + \pi^+ +$ recoils at 1.15 Bev/c that show a sharp enhancement at 1415 Mev were discussed. Predictions concerning the resonant state Y_2^* (1415) in the framework of SU_3 symmetry are considered, and the existence of resonant states in the $K^+ - p$ (or $K^- - \Xi^-$) system is discussed. (C.E.S.)

18802 ON THE VERTEX PART OF COMPOSITE PARTICLES. T. Yoshimura (Israel Inst. of Tech., Haifa). Nuovo Cimento (10), 35: 674-5(Jan. 16, 1965).

If some of the so-called elementary particles are, as previously suggested, generated dynamically as composite particles by the strong interactions of the others, it is an important problem to formulate and calculate the vertex part, etc. of composite particles off the mass shell. Such attempts have been made with the rather curious conclusions that the (renormalized) vertex part with a composite particle off the mass shell vanishes identically and that $Z_1 = Z_3 = 0$ independently of the behavior at the high-energy limit. The validity of the conclusion that a vertex part with two elementary external lines and an external composite particle off the mass shell vanishes is discussed. (C.E.S.)

18803 POSSIBLE THEORETICAL INTERPRETATIONS OF THE T = 2 π-Σ RESONANCE. I. P. Gyuk, W. A. Simmons, and S. F. Tuan (Purdue Univ., Lafayette, Ind.). Nuovo Cimento (10), 35: 676-81(Jan. 16, 1965).

Recent experimental work on $K^- + n(C) \rightarrow \Sigma^- + \pi^- + \pi^+ +$ recoils in a 1.15-Bev/c K^- interaction with a neutron in carbon that gave evidence of the existence of a T = 2 π-Σ resonance of narrow width and mass value 1415 Mev is discussed. Since such a state, if confirmed, will raise serious questions about the role it will play in SU_3 classification of baryon resonances, possible theoretical interpretations of this state are discussed. (C.E.S.)

18804 FINAL-STATE INTERACTIONS IN $K \rightarrow 3\pi$ DECAYS. R. Prasad (University Coll., London). Nuovo Cimento (10), 35: 682-7(Jan. 16, 1965).

An analysis is presented of the final-state interactions in the decay modes $K^+ \rightarrow \pi^+ + \pi^+ + \pi^-$, $K^+ \rightarrow \pi^0 + \pi^0 + \pi^+$, and $K_2^0 \rightarrow \pi^+ + \pi^- + \pi^0$. (C.E.S.)

18805 REGGE EXCHANGE MECHANISM FOR INELASTIC REACTIONS. V. Barger (Univ. of Wisconsin, Madison). Nuovo Cimento (10), 35: 700-2(Jan. 16, 1965). (COO-30-96)

A straightforward experimental test of the Regge pole mechanism for quasi-two-body production reactions $a + b \rightarrow c + d$ in which a single-meson trajectory z is expected to dominate the crossed t-channel, i.e., $a + \bar{c} \rightarrow z \rightarrow \bar{b} + d$ is considered. It is suggested that the isobar production reactions $\pi^+p \rightarrow \pi^0N^{*2+}_{\frac{3}{2}}$ and $K^+p \rightarrow K^0N^{*2+}_{\frac{3}{2}}$ probably provide the most immediate application of the derived results. (C.E.S.)

18806 A NOTE ON K_{l3} DECAY. W. Williamson, Jr. (Univ. of Michigan, Ann Arbor). Nuovo Cimento (10), 35: 706-8(Jan. 16, 1965).

The consequences of nonlocality and CP violation in K_{l3} decay are discussed. (C.E.S.)

18807 GLOBAL MASTER EQUATION. [PART] II. G. Sandri (Aeronautical Research Associated of Princeton, Inc., N. J.). Nuovo Cimento (10), 36: 309-21(Mar. 16, 1965).

The structure of the global master equation is clarified by means of a projection operator formalism which allows one to exhibit the physical meaning of the quantities that appear in the evolution of the momentum distribution. With the help of the new formulation, an explicit form to the H-theorem for the master equation is given, and the effect of phase mixing on the propagator is calculated to first order. (auth)

18808 GENERATION OF BARYONS AND RESONANCES IN BROKEN SU_3 SYMMETRY. B. Diu, H. R. Rubinstein, and J. L. Basdevant (Universite de Paris, Orsay, France). Nuovo Cimento (10), 36: 321-61(Mar. 16, 1965).

The dynamical hypothesis of generation of particles via one-particle exchange graphs, that proved successful in early calculations is analyzed in the case of baryonic amplitudes. A simple criterion that seems to work in the mesonic case is shown to be unapplicable. More complicated ones are used with the hope that the type of questions being asked are insensitive to detailed arguments. At this stage the main question is posed: which is the relation between higher symmetries and the analyticity point of view when breakdowns of the former are allowed? It is found that the generation of the resonance decuplet as performed by Martin and Wali can be understood both in terms of broken SU_3 and analyticity, though mixing between representations is rather strong. When the reciprocal bootstrap idea of generating baryons by decuplet exchange is tried, difficulties appear that are very serious. A model is proposed that generates the baryons via vector meson exchange. It stands the proposed tests better than the reciprocal bootstrap model but is not completely free of difficulties. As a fundamental difference, it predicts a ninth baryon, that belongs to a singlet representation. (auth)

18809 GENERALIZED ONE-DIMENSIONAL SCATTERING PROCESSES WITH APPLICATIONS IN THREE DIMENSIONS. P. J. Brockwell (Australian National Univ., Canberra). Nuovo Cimento (10), 36: 370-84(Mar. 16, 1965).

Results which have been obtained by Brockwell and Moyal for one-dimensional scattering processes, in which the distances between successive collisions have a negative exponential distribution, are generalized to include processes where the distribution is either a γ-distribution or a linear combination of negative exponential distributions. The results are applied to the scattering of particles in three dimensions leading to an improvement on the results of Fermi. (auth)

18810 A FIELD-THEORETIC PROOF OF A MODIFIED VERSION OF LEVINSON'S THEOREM. J. M. Charap (NIRNS, Chilton, Berks, Eng. and Imperial Coll. of Science and Tech., London). Nuovo Cimento (10), 36: 419-35 (Mar. 16, 1965).

A consideration of the integral equation for the vertex function derived from field theory leads to a proof of a new form of Levinson's theorem. The number of CDD poles, which occur at first-sheet zeros of the vertex function, must be supplemented by the number of second-sheet zeros of the vertex function, at which points occur the poles of the amplitude associated with particles for which the wave-function renormalization constant vanishes. (auth)

18811 INDUCED PHOTON-MESON COUPLINGS AND THE DECAY $\pi^0 \rightarrow \gamma e^+e^-$. G. Barton and B. G. Smith (Univ. of Sussex, Brighton, Eng.). Nuovo Cimento (10), 36: 436-62(Mar. 16, 1965).

The effective coupling constants $f_{\rho\pi\gamma}$, $f_{\varphi\pi\gamma}$, and $f_{\omega\pi\gamma}$ are calculated from the first principles by using single-variable dispersion representations. Baryon-antibaryon intermediate states are taken to dominate the calculation, and the reasons for this are discussed. The special case in which vector mesons dominate the baryon electromagnetic form factors, and the general case, in which they do not are considered. In the general case, meaningful equations can result only when the pion, alone, is taken off the mass shell, and then only if one subtraction is made at infinity. A convergence condition must be imposed on the integrand; the result is determined by this condition alone, and consequently depends only on the high-energy behavior of the spectral function. In the special case, either the pion or the photon can be taken off the mass shell, both choices leading to the same result. On the assumption of vector dominance, this circumstance reconciles a result of Feldman and Matthews with a model of Gell-Mann, Sharp and Wagner. The results can be evaluated only provisionally, for lack of reliable input data on the strong interactions; such results as do emerge conform to experiment. The same methods are used to calculate the dependence of the $\pi^0 \rightarrow \gamma e^+e^-$ amplitude on the squared total mass of the Dalitz pair, i.e. of the virtual γ. In contrast to previous approaches, it is found that in general a once-subtracted dispersion relation must be used; the subtraction constant must be supplied by an independent calculation of $f_{\pi\gamma\gamma}$ in which only the pion leaves the mass shell. The result (like previous ones) contradicts experiment as regards the magnitude of the dependence and, less unambiguously, as regards its sign; but, short of abandoning very basic theoretical ideas, there remains much less scope than formerly for reconciliation with experiment. A remeasurement is recommended. (auth)

18812 ON THE PARTIAL-WAVE AMPLITUDES FOR THREE-BODY SCATTERING. D. Tadic and T. F. Tuan (Univ. of Birmingham, Eng.). Nuovo Cimento (10), 36: 463-82(Mar. 16, 1965).

Analyticity properties in the three-body angular momentum plane were investigated using the iterative solution of the Fadeev's equations. In the right half-plane its members can have cuts arising from the two-body Regge poles only. It is possible to continue in such a way as to avoid them. For a special, exactly solvable model it is shown that they do cancel in the exact solution. (auth)

18813 EFFECTS ON THE ρ-NUCLEON TOTAL CROSS-SECTION ON PHOTOPION PRODUCTION IN THE FORWARD DIRECTION. S. M. Berman and U. Maor (Stanford Univ., Calif.). Nuovo Cimento (10), 36: 483-7(Mar. 16, 1965). (SLAC-Pub-38)

The possible contribution of a ρ-exchange process to the photoproduction of mesons (φ) which subsequently decay to high-energy mesons (π) at very small angles, is examined when the ρ-nucleon vertex is replaced by the total cross section for ρ-induced reactions. (auth)

18814 MESON-BARYON RESONANCES IN $U_3 \otimes U_3$ SYMMETRY. [PART] II. I. S. Gerstein and K. T. Mahanthappa (Univ. of Pennsylvania, Philadelphia). Nuovo Cimento (10), 36: 488-508(Mar. 16, 1965).

The assignment of the $J = \frac{3}{2}^+$ meson-baryon resonances to the 45 dimensional representation of Schwinger's W_3 symmetry is considered; mass formulas for the 27-plet and the octet were obtained. The various possibilities of assigning charges to the fundamental triplets in this theory and the possibilities of constructing particle states from them are discussed. The mass operator is discussed, and it is shown that the single requirement of no mixing in a certain representation is sufficient to yield Gell-Mann–Okubo mass formulas; this requirement imposes the condition that the mass operator transform like a unitary

singlet plus the neutral component of a unitary octet. Clebsch-Gordan coefficients involving some nonoctet representations of SU_3 using the phase convention of de Swart, are tabulated. (auth)

18815 PERIPHERAL PRODUCTION OF SINGLE PIONS AND KAONS BY NEUTRINOS. G. R. Henry, J. Loevseth, and J. D. Walecka (CERN, Geneva). Nuovo Cimento (10), 36: 509-22(Mar. 16, 1965).

The cross sections and bosons energy spectra of the reactions $\nu + \mathcal{N} \rightarrow \mathcal{N} + l^- + \pi^+$, $\nu + \mathcal{N} \rightarrow \mathcal{N} + l^- + K^+$, $\nu + \mathcal{N} \rightarrow Y + l^- + K^+$ are computed in the peripheral approximation. The dependence of the cross section and boson energy spectrum on form factors is discussed. The results are compared to the recent CERN neutrino experiments. (auth)

18816 BETA-DECAY COUPLING CONSTANTS. Y. S. Kim (Univ. of Maryland, College Park). Nuovo Cimento (10), 36: 523-32(Mar. 16, 1965).

Dispersion relations are introduced which give the same asymptotic value for the vector and axial-vector form factors in the limit of high momentum transfer. The ratio g_A/g_V is related to the behavior of the vector form factor in the region of low momentum transfer. The numerical value $g_A/g_V \simeq -1.2$ is obtained from the experimental curves for the electromagnetic form factors. (auth)

18817 THE MESON-NUCLEON COUPLING CONSTANTS IN HEISENBERG'S NONLINEAR FIELD THEORY. J. Dhar (Max-Planck-Institut fur Physik and Astrophysik, Munich) and Y. Katayama. Nuovo Cimento (10), 36: 533-41(Mar. 16, 1965).

The coupling constants of π and η mesons with nucleons were calculated within the framework of Heisenberg's nonlinear field theory. The calculations were carried out by using a new iteration procedure. The pseudoscalar coupling turn out to be independent of the constant l occurring in the fundamental equation and they are also rather insensitive to the meson-nucleon mass ratios. The numerical values of η-nucleon and π-nucleon coupling constants turn out to be 8.07 and 12.20, respectively, if we use the values of κ_η/κ and κ_η/κ which follow from the theory, and 11.10 and 12.5, respectively, if the empirical mass ratios are used. (auth)

18818 NONLEPTONIC DECAYS OF THE INTERMEDIATE BOSON. V. Namias and L. Wolfenstein (Carnegie Inst. of Tech., Pittsburgh). Nuovo Cimento (10), 36: 542-53(Mar. 16, 1965).

Decays of the weak-interaction intermediate boson into two pseudoscalar mesons or into a pseudoscalar and a vector meson are calculated. The ratios of various decay modes predicted by the octet hypothesis for the weak interaction current and by assumed transformation properties under G are given. (auth)

18819 A FORMALISM FOR PARITY-NONCONSERVING REACTIONS. [PART] I. K. Raman (MATSCIENCE, Inst. of Mathematical Sciences, Madras). Nuovo Cimento (10), 36: 554-68(Mar. 16, 1965).

A formalism for the analysis of a general parity-nonconserving reaction is developed. The formalism is based on the introduction of parity-preserving and parity-changing helicity amplitudes. The partial-wave unitarity relation and the crossing relations for general reactions are expressed in terms of this formalism. The notion of maximal nonconservation of parity is discussed, and the condition for it is obtained. Finally a simple example is worked out to illustrate the present formalism. (auth)

18820 A FORMALISM FOR PARITY-NONCONSERVING REACTIONS. II. POLARIZATION. K. Raman (MATSCIENCE, Inst. of Mathematical Sciences, Madras). Nuovo Cimento (10), 36: 569-85(Mar. 16, 1965).

A formalism for the analysis of polarization effects in a general parity-nonconserving reaction is developed. The polarization formalism is developed in terms of a basis of helicity states. General expressions are derived for the longitudinal, transverse, and multipole components of the final polarization in terms of the parity-preserving and parity-changing amplitudes when the polarization of the initial state is specified. The general properties of these results are noted, and some applications are briefly discussed. (auth)

18821 ANALYTICITY OF BOUND-STATE SCATTERING AMPLITUDES. J. T. Cushing PImperial Coll. of Science and Tech., London). Nuovo Cimento (10), 36: 586-603 (Mar. 16, 1965).

The Fadeev equations describing the nonrelativistic scattering of three particles are used to construct the amplitude corresponding to the elastic scattering of one particle from a bound-state of the other two for the case in which all the two-body interactions involved are separable. The bound-state scattering amplitude is shown to have both Regge poles and cuts in the right-half angular momentum plane. Also, the left-half l-plane for a specific interaction is discussed. Finally, the Regge trajectory for the bound-state scattering amplitude is shown to be bounded in the right-half l-plane as the energy of the scattered particle, relative to the bound-state scatterer, tends to infinity through real, positive values. (auth)

18822 PRODUCTION OF LIGHT BOSONS BY CENTRAL COLLISIONS AT VERY HIGH ENERGIES. G. Auberson and B. Escoubes (CERN, Geneva). Nuovo Cimento (10), 36: 628-53(Mar. 16, 1965).

The asymptotic behavior (for $E \rightarrow \infty$) of the statistical model is investigated. It is shown that (if new particles with larger and larger masses do not appear) the masses of the particles may be neglected when $E \rightarrow \infty$. Then the phase-space integrals have a well-known analytical form and asymptotic expressions for sums over all channels—i.e., sums of the type $\Sigma_{n=2}\, \Omega^n(1/n!)\rho_n(E)$—can be found. It is shown that larger-angle elastic scattering will behave like $d\sigma/d\Omega \sim \exp[-aE^\alpha]$ with $\alpha = \frac{1}{2}, \frac{2}{3}, \frac{3}{4}, 1$, according to what the detailed assumptions about the kind of particles and interactions are. Finally it is shown that the same results can be found from simple thermodynamical considerations. (auth)

18823 CORRECTION TO THE POTENTIAL IN BORN APPROXIMATION ARISING FROM DIRECT CHANNEL STRIPS. M. Der Sarkissian (Univ. of California, Livermore). Nuovo Cimento (10), 36: 654-62(Mar. 16, 1965).

The $\pi\pi$ partial wave amplitude is studied in the 1-channel approximation for the states $l = 1$, $I = 1$ and $l = 2$, $I = 0$. The Born approximation to the force operating in the direct channel is assumed to be saturated by ρ-exchange in the crossed reactions for both states. This amounts to a strip approximation to the force. However, the direct channel strips must also contribute to the potential and it is important to ask how significant this correction is for $\pi\pi$ scattering. It is found that the effect produces an additional attractive force in both states and that the effect is not overwhelming in either state and may very well be negligible. (auth)

18824 THE EFFECT OF FINAL-STATE INTERACTIONS ON THE ASYMMETRY PARAMETER IN CASCADE DECAY PROCESSES. Ravinder Nath and Aditya Kumar (Univ. of Delhi). Nuovo Cimento (10), 36: 669-71(Mar, 16, 1965).

An attempt was made to estimate the $\Lambda - \pi$ phase shifts in the decay of the hyperon (Ξ^-) in order to determine the cascade asymmetry parameter. The N/D method was used. (C.E.S.)

18825 ON THE "SPACE-TIME CHARACTER" OF INTERNAL SYMMETRIES OF ELEMENTARY PARTICLES. D. Bohm (Birkbeck Coll., London), M. Flato, F. Halbwachs, P. Hillion, and J.-P. Vigier. Nuovo Cimento (10), 36: 672-5(Mar. 16, 1965).

The possibility of interpreting the isotopic-spin space as reflecting real internal motions in Minkowski space is considered. The problem of finding relations between external spin J and mass(squared) $p_\mu p^\mu$ on the one hand and internal quantum numbers (like I, I_3, Y) on the other hand is discussed. Mathematically, the problem is formulated as follows: given the Poincaré group and the internal sym-

metry group. find a group that contains both, and that connects them in a nontrivial way. (C.E.S.)

18826 A NOTE ON $SU_3 \otimes SU_3$-SYMMETRY. J. Iizuka and Y. Miyamoto (Tokyo Univ. of Education). Nuovo Cimento (10), 36: 676-9(Mar. 16, 1965).

The nonleptonic interaction of hyperons and the mass splitting between the two sets of meson–baryon resonances ($P^+_{\bar{3}}$ – decuplet and $D^-_{\bar{3}}$ – octuplet) under the $SU_3 \otimes SU_3$ symmetry are discussed. (C.E.S.)

18827 $\tilde{U}_{12}$ AND BROKEN SU_6 SYMMETRY. R. Delbourgo, Abdus Salam, and J. Strathdee (International Center for Theoretical Physics, Trieste). Nuovo Cimento (10), 36: 689-92(Mar. 16 1965).

Starting with a spin-½ quark model the most general algebraic structure is the $\tilde{U}(12)$ ring of matrices $\gamma^\mu T^\nu$. It is pointed out that this $\tilde{U}(12)$ structure can be used to give a direct covariant formulation of the SU_6 symmetry provided that for the physically realized multiplets one writes not only the composite field operators but also their conjugate-momentum operator as independent components within the same multiplet. (C.E.S.)

18828 DOMINANCE THEOREM IN CROSSING MATRICES IN ARBITRARY COMPACT GROUP. N. Masuda (Nihon Univ., Tokyo). Nuovo Cimento (10), 36: 693-6 (Mar. 16, 1965).

The dominance theorem in crossing matrices in SU_2 and SU_3 groups is discussed. It is shown that this theorem holds generally in an arbitrary compact group. That is, the absolute magnitude of the nonvanishing crossing-matrix element between the s-channel amplitude in the singlet state and the t- or u-channel amplitude in a given arbitrary multiplet state is never smaller than that of the crossing-matrix element between the s-channel amplitude in an arbitrary multiplet state and the t- or u-channel amplitude in a given arbitrary multiplet state. (C.E.S.)

18829 POLARIZATION OF 30 Mev PROTONS ELASTICALLY SCATTERED FROM DEUTERONS. S. J. Hall, A. R. Johnston, and R. J. Griffiths (Queen's Univ., Belfast). Phys. Letters, 14: 212-14(Feb. 1, 1965).

Polarization measurements for elastic proton-deuteron scattering were extended to 35.5° cm. The scattered particles were detected by two plastic scintillators placed at the left and right of the incident proton beam; the beam polarization was monitored by a carbon target polarimeter, and the left-right asymmetry was measured by a second polarimeter. The results are compared with measurements obtained by coincidence methods. (L.B.S.)

18830 THE MASS DIFFERENCES OF THE SIGMA HYPERONS. H. C. Dosch, R. Engelmann, H. Filthuth, V. Hepp, E. Kluge, K. Marish, and A. Minguzzi-Ranzi (Univ. of Heidelberg). Phys. Letters, 14: 239-40(Feb. 1, 1965).

The $(\Sigma^- - \Sigma^+)$ and $(\Sigma^- - \Sigma^0)$ mass differences were determined from momenta measurements in an analysis of events produced in the Saclay hydrogen bubble chamber which was exposed to a stopping K^- beam at the Cern proton synchrotron. The results are compared with theoretical predictions and other experimental results. (L.B.S.)

18831 DOUBLE ISOBAR PRODUCTION IN 10 Gev/c PROTON-PROTON COLLISIONS. S. P. Almeida, H. W. Atherton, T. A. Byer, P. J. Dornan, A. G. Forsan, J. H. Scharenguivel, D. M. Sendall, and B. A. Westwood (Cambridge Univ., Eng.). Phys. Letters, 14: 240-2(Feb. 1, 1965).

An analysis was made of interactions of 10-Bev/c protons occurring in the Saclay hydrogen bubble chamber which was exposed to a beam from the Cern proton synchrotron. The $p\pi^+$ and $p\pi^-$ invariant masses for the reaction $p + p \rightarrow p + p + \pi^+\pi^-$ are plotted, and evidence for the presence of the N^{*2+} (1238), N^{*0} (1238), and N^{*0} (1688) was found. (L.B.S.)

18832 N* PRODUCTION BY NEUTRINOS AND SU(6). N. J. Papastamatiou and D. G. Sutherland (Oxford Univ.). Phys. Letters, 14: 246-7(Feb. 1, 1965).

The predictions of SU(6) symmetry for the production of N* in neutrino experiments are discussed. Preliminary results of a Cern experiment are shown to be consistent with the SU(6) predictions for the axial vector transition. (L.B.S.)

18833 SIMULTANEOUS ANALYTIC CONTINUATION TO THE SECOND SHEET IN TWO CROSSED CHANNELS AND THE DETERMINATION OF COUPLING CONSTANTS. A. O. Barut and T. Sawada (International Atomic Energy Agency, Trieste, Italy). Phys. Letters, 14: 248-9(Feb. 1, 1965).

It is shown that the postulate which allows an exact determination of coupling constants within the context of strong interactions can be reduced to a generalized form of analyticity to the effect that the scattering amplitude is made as analytic as possible in all its Riemann sheets, provided that the unitarity condition is not violated in all channels. (L.B.S.)

18834 f^0 APPROACHES 4π DECAY AND THE AXIAL VECTOR ρ MESON. C. S. Lai (Univ. of Chicago). Phys. Letters, 14: 250-1(Feb. 1, 1965).

The relation between the coupling constants $g_{f\pi\pi}$ and $g_{f4\pi}$ of the f^0 meson is explored within the framework of the partially conserved axial vector current assuming an axial vector resonance. The part of the four-pion decay rate which proceeds by the $f^0 \rightarrow \tilde{\rho} + \pi$ process is calculated from $g_{f\pi\pi}$, and the mass of the axial vector ρ meson is obtained, assuming that this process dominates the $f^0 \rightarrow 4\pi$ decay. The partial width $\Gamma(f^0 \rightarrow \tilde{\rho}\pi)$ is calculated, and numerical results are presented as a function of $m_{\tilde{\rho}}$. (L.B.S.)

18835 A SEARCH FOR A POSITIVE STRANGENESS BARYON. L. Lyons and O. I. Dahl (Nuclear Physics Lab., Oxford). Phys. Letters, 14: 255-7(Feb. 1, 1965).

A search was made for the $\pi^- p \rightarrow Z^+K^-$ reaction with incident pions at 1.65 to 2.15 Bev/c in a hydrogen bubble chamber. No evidence was found for the existence of a strangeness +1 baryon in the mass region below the NK threshold. (L.B.S.)

18836 EQUIVALENT FORMULATIONS OF THE SU_6 GROUP FOR QUARKS. F. Guersey (Middle East Technical Univ., Ankara). Phys. Letters, 14: 330-1(Feb. 15, 1965).

Applications of the general theory of relativistic invariance are applied to the special case of the lowest (6-dimensional) representation of SU(6) corresponding to quarks. Results are derived concerning the operators, the Foldy-Wouthuysen representation, the invariant hamiltonian, the Newton-Wigner position operators, and the c-number Dirac spinor associated with quark particle states. (L.B.S.)

18837 MASS RELATIONS AND THE "SUPER-LORENZ GROUP" L. T. Fulton and J. Wess (Universitat, Vienna). Phys. Letters, 14: 334-6(Feb. 15, 1965).

The significance of the thirty-six Hermitian momentum operators introduced in the generalization of Lorentz groups L_H to the inhomogeneous group L is discussed. It is shown that the mass-squared operator is a specific set of components of a L-covariant tensor, which yields the Gell-Mann–Okubo mass formula. (L.B.S.)

18838 K* RESONANCES PRODUCED BY 3.5 Gev/c K^- INTERACTIONS IN HYDROGEN. H. Haque (Univ. of Birmingham, Eng.). D. Scotter, B. Musgrave et al. Physl Letters, 14: 338-42(Feb. 15, 1965).

An analysis was made of 300,000 pictures of 3.5 Bev/c K^- interactions in the Saclay 80-cm hydrogen bubble chamber, and the total cross section was found for the $K^- + p \rightarrow \bar{K}^0 + \pi^- + p$ interaction. The $\bar{K}^0\pi^-$ effective mass distribution, the Dalitz plot of the reaction and the squared momentum transfer distribution for events in the $\bar{K}\pi$ mass regions 890 and 1400 Mev are shown. It was found that: the K* (890) dominates the reaction, its production occurring mainly by vector exchange; a K* (1400) occurs with a width $\gamma \sim 160$ Mev; and upper limits for the production of N* and Y* in this state are ~ 50 μb and ~ 5 μb for the K. (L.B.S.)

18839 POSSIBLE CP VIOLATING, PT CONSERVING, SCALAR-PSEUDOSCALAR INTERACTION. S. N. Lotsoff (Univ. of Chicago). Phys. Letters, 14: 344-6(Feb. 15, 1965).

The possible existence of a PT conserving scalar-pseu-

doscalar CP violating coupling which is consistent with present data is pointed out. The effect of a small PT invariant S-P coupling on the branching ratio between the muon and electron decay of charged pions is examined, and the interaction hamiltonian is written. The two pion decay modes of the neutral K mesons is also examined. (L.B.S.)

18840 THE BARYON-MESON COUPLING IN A THEORY WHICH DESCRIBES SU(6) SYMMETRY IN A RELATIVISTICALLY INVARIANT WAY. W. Ruehl (CERN, Geneva). Phys. Letters, 14: 346-8(Feb. 15, 1965).

The meson-baryon vertex is studied in a group theoretical model G, which involves the complete inhomogeneous Lorentz group. Expressions for the meson and baryon representations are given, under the conditions that the invariant subgroup of translations consists of two dual real vector spaces, and the momentum matrices of the physical properties contain only the SU(3) scalar components. The expressions are evaluated directly by means of the field equations and the results are presented. (L.B.S.)

18841 A MODEL OF PC VIOLATION. W. Alles (CERN, Geneva). Phys. Letters, 14: 348-50(Feb. 15, 1965).

A model of weak interactions is constructed based on a current-current Lagrangian leading to the small P-C violation observed in $K_0^2 \to 2\pi$, and allowing larger effects in neutron or Λ decay. Leptonic and semileptonic processes are also discussed. (L.B.S.)

18842 EVIDENCE FOR P-WAVE DECAY OF Σ^+ TO $\pi^+ + N^*$. R. B. Willmann and T. H. Groves (Purdue Univ., Lafayette, Ind.). Phys. Letters, 14: 350-2(Feb. 15, 1965).

A liquid hydrogen bubble chamber was exposed to π^+ mesons of 1111, 1206, and 1265 Mev/c, and $\pi^+ + p \to \Sigma^+ K^+$ interactions with the Σ^+ decaying to $(\pi^+ n)$ were analyzed. The polarization of Σ^+ was calculated using a partial wave analysis, and the spin vector of the neutron was calculated for s-wave and p-wave decay. From the calculated likelihood function, the results show that the decay proceeds through p-wave by 1.43 to 1. Results are also given of Monte Carlo calculations, assuming s-wave decay. (L.B.S.)

18843 ASSIGNMENT OF HIGHER BOSON RESONANCES TO A p-WAVE MULTIPLET OF SU_6. E. Borchi (Universita, Florence) and R. Gatto. Phys. Letters, 14: 352-4 (Feb. 15, 1965).

An assignment is proposed of higher boson resonances to a multiplet of dimension 105, which behaves like $\underline{35}$ under SU(6) and like a p-wave under orbital rotations. A mass formula is derived from an approximate model of symmetry breaking consisting of a sum of two terms of $\underline{35}$, one transforming like φ^0 and one like η^0. The proposed assignment and predictions for the masses and quantum numbers are illustrated. (L.B.S.)

18844 PERIPHERAL INTERACTIONS AND SU(3) SYMMETRY. S. N. Biswas (Univ. of Delhi), V. S. Mathur, and R. P. Saxena. Phys. Letters, 14: 355-6(Feb. 15, 1965).

The consequences of SU(3) symmetry in processes of the type $P + B \to P + P + B$ are investigated, assuming a peripheral mechanism for the three body production phenomena. The vertex functions and scattering amplitudes are listed for processes where a pseudoscalar meson ie exchanged and the outgoing pseudoscalar mesons are in a relative p-wave. Sum rules are derived, using a dynamical model and the results are found to be in agreement with experimental data. (L.B.S.)

18845 TWO-PION DECAY OF K_2^0 AT 10 Gev/c. X. De Bouard (CERN, Geneva), D. Dekkers, B. Jordan, R. Mermod, T. R. Willitts, K. Winter, P. Scharff, L. Valentin, M. Vivargent, and M. Bott-Bodenhausen. Phys. Letters, 15: 58-61(Mar. 1, 1965).

The detection system, using scintillation and Cherenkov counters, is described. Two-body decays of K_2^0 were observed and determined to be pions. The possible energy dependence of the two-pion decay rate was studied by comparing the rate measured at 10 Bev/c with previous results for 1.1 Bev/c. Upper limits were found for other unknown weak forces which may add terms of the form by^n to the decay rate into two pions. An upper limit for the branching ratio for the two-muon decay was also obtained. (M.J.T.)

18846 N/D EQUATIONS WITH NON-UNIQUE SOLUTIONS. G. Auberson and G. Wanders (Universite, Lausanne, Switzerland). Phys. Letters, 15: 61-3(Mar. 1, 1965).

The N/D method for the P-wave scattering of two equal-mass scalar mesons is considered. The scattering amplitude is expressed in terms of functions N(z) and D(z), where N(z) and D(z) are given by integral equations. A direct proof of the nonuniqueness of the resolvent of the inhomogeneous equation for N(z) is presented, for one case describing the left-hand cut in N(z); the situation for other classes of discontinuities is discussed briefly. (M.J.T.)

18847 SELF-CONSISTENT CALCULATION OF THE K* PARAMETERS. G. Payne (Pennsylvania State Univ., University Park). Phys. Letters, 15: 63-5(Mar. 1, 1965).

It is pointed out that f_0 exchange, as well as ρ exchange, gives an important contribution to the binding force of the $I = \frac{1}{2}$, p-wave resonance, the K*, which is produced in πK scattering. A self consistent determination of the K* parameters, using the method of Balzas, is reported. A mass of 750 Mev and a width of 90 Mev are obtained. (M.J.T.)

18848 A MEASUREMENT OF THE MAGNETIC MOMENT OF THE Λ^0 HYPERON. G. Charriere (Laboratoire de Recherches Nucleaires, EPUL, Lausanne, Switzerland), M. Gailloud, Ph. Rosselet, et al. Phys. Letters, 15: 66-9 (Mar. 1, 1965).

Polarized Λ hyperons were produced in the interaction $\pi^- + p \to \Lambda^0 + K^0$ at 1.05 Gev/c, and the direction of the polarization vector was observed after the hyperons passed through a strong magnetic field, by means of the asymmetry in the decay $\Lambda^0 \to \pi^- + p$. The arrangement of target, magnetic field, and nuclear emulsions is described. The process of scanning and track measurement of the emulsions is discussed. The analysis was made using 151 events with Λ momentum $\geq$650 Mev/c; a value of $\mu_\Lambda = -0.5 \pm 0.28$ nucleon magnetons was obtained. (M.J.T.)

18849 A_1 AND A_2 RESONANCES IN π^-p INTERACTIONS AT 2.75 Gev/c. J. Alitti (CEN, Saclay, France), J. P. Baton, B. Deler, M. Neveu-Rene, J. Crussard, J. Ginestet, A. H. Tran, R. Gessaroli, and A. Romano. Phys. Letters, 15: 69-72(Mar. 1, 1965).

A discussion is given of evidence on the A_1(1080) and A_2 (1310) resonances from analysis of 5500 four-prong and 10,645 two-prong events produced in π^-p interactions at 2.75 Bev/c in a H bubble chamber. Interactions corresponding to $\rho^0\pi^-$, $\rho^-\pi^0$, and $\eta\pi^-$ decays were studied, using data from 4634 events. The $(\rho\pi)$ decay modes are discussed; spin and parity determinations of 1^+ and 2^+ for A_1 and A_2 respectively are found to be the most probable. Data on the $(\eta\pi)$ decay mode seem to contradict the $(\rho\pi)$ decay analysis, implying the existence of a different resonance. (M.J.T.)

18850 RADIATIVE CORRECTIONS TO e-p SCATTERING COINCIDENCE EXPERIMENTS. K. Kajantie (Univ. of Lund, Sweden). Phys. Letters, 15: 73-4(Mar. 1, 1965).

A formula is presented for the radiative corrections for an e-p elastic scattering coincidence experiment in which the detectors used have good energy resolutions compared with their angular resolutions. The calculation of the cross sections for this coincidence experiment is outlined. (M.J.T.)

18851 FURTHER EVIDENCE FOR A $K\pi\pi$ RESONANCE AT 1175 Mev. D. H. Miller, A. Z. Kovacs, R. L. McIlwain, T. R. Palfrey, and G. W. Tautfest (Purdue Univ., Lafayette, Ind.). Phys. Letters, 15: 74-6(Mar. 1, 1965).

An analysis was made of 242 events of the type $YK\pi\pi$ in π^-p interactions at 2.7 Bev/c. Mass spectra of $K\pi\pi$ for the $YK\pi\pi$ events, of $K\pi\pi$ and $K^*\pi$ after removing the Y* band, and of $K\pi\pi$ after removing all events with a possible K* or Y* are presented. The existence of a resonance at 1160 $\pm$ 10 Mev, with a width of 35 $\pm$ 10 Mev and a production cross section of 20 $\pm$ μb, is demonstrated. (M.J.T.)

18852 A PHYSICAL SUM RULE ON THE REAL PART OF THE PION NUCLEON FORWARD SCATTERING AMPLITUDE. A. Martin (CERN, Geneva). Phys. Letters, 15: 76-8(Mar. 1, 1965).

It is pointed out that a sum rule on the real part of the

forward scattering amplitude, which could constitute a test of dispersion relations, can be written containing only physical quantities, using the procedure of Kinoshita and Khuri. Sum rules favoring calculations at both low and high energies are obtained. (M.J.T.)

18853 $\tilde{U}(12)$ AND VECTOR MESON DECAYS. F. Hussain (Imperial Coll. of Science and Tech., London). Phys. Letters, 15: 78-9(Mar. 1, 1965).

The group $\tilde{U}(12)$ was suggested previously as the covariant generalization of SU(6), and an expression was given for the three meson vertex. The mixing of the unphysical SU(3) singlet ϕ^0 and the octet member ϕ^8 is defined, and ratios of decay rates are found for decays of the vector mesons ϕ, ρ, and K^*. The use of quark spin conservation in $\tilde{U}(12)$ to obtain selection rules is mentioned. (M.J.T.)

18854 EXPERIMENTAL IMPLICATIONS OF $U(6) \otimes U(6)$-INVARIANCE FOR BARYONS. K. Bardakci, J. M. Cornwall, P. G. O. Freund, and B. W. Lee (Inst. for Advanced Study, Princeton, N. J.). Phys. Letters, 15: 79-81 (Mar. 1, 1965).

Baryon number B = 1 states belonging to the representation (21,6) + (6,21) with L = 0 of $W_6 = U(6) \otimes U(6)$ are considered. The lowest lying baryon states with even and odd parity are fitted into the 56- and 70-plet respectively of this representation. Three sum rules connecting the masses of particles from the 56 and 70 representations are derived and tested. Experimental favoring of N-type over M-type W_6 invariance is discussed. The sum rules are found to be evidence for a symmetry higher than U(6), most likely of the type $U(6) \otimes U(6)$. (M.J.T.)

18855 EVIDENCE FOR RHO PRODUCTION IN K^-d INTERACTION AT 2.24 Gev/c. E. D. Alyea, Jr., R. R. Crittenden, H. J. Martin, Jr., J. I. Rhode, and J. H. Scandrett (Indiana Univ., Bloomington). Phys. Letters, 15: 82-3(Mar. 1, 1965).

Ninety-five $K^-d \rightarrow \Sigma^-\pi^+\pi^-p$ events were found in exposing a D bubble chamber to a 2.24-Bev/c K^- beam; 81 are interpreted with the proton as a spectator particle. Mass distributions are given, and evidence for the ρ meson, with 735 ± 10 Mev mass and 110 ± 20 Mev width, is found in the $\pi^+\pi^-$ distribution. The density matrix elements for the rho are calculated by a maximum likelihood analysis of angular distribution data; it is indicated that vector meson exchange is the dominating mechanism in rho production. (M.J.T.)

18856 BARYON ELECTROMAGNETIC MASS DIFFERENCES AND SU_6-SYMMETRY. A. D. Dolgov, L. B. Okun, I. Ya. Pomeranchuk, and V. V. Solovev (Academy of Sciences, Moscow). Phys. Letters, 15: 84-5(Mar. 1, 1965).

A table is given of electromagnetic mass differences of the baryon 56-plet, calculated using the model of nonrelativistic quarks in SU(6) symmetry. Values are compared with experimental ones. It was assumed that the quarks are in a state with zero total orbital momentum, and that the mass differences are due to the electromagnetic mass differences between u quarks and s, d quarks, to the Coulomb interaction between quarks, and to the interaction between magnetic moments of quarks. (M.J.T.)

18857 ON SU_6-SYMMETRY OF ELEMENTARY PARTICLES. Yu. V. Novozhilov and I. A. Terentiev (Leningrad State Univ.). Phys. Letters, 15: 86-7(Mar. 1, 1965).

The group $P(SU_6)$, some nontrivial extension of the Poincaré group, is considered, and its main features are analyzed. The subgroup SU_6 is used to construct the physical model based on $P(SU_6)$. (M.J.T.)

18858 POSSIBILITY OF CP VIOLATION IN SEMI-STRONG INTERACTIONS. J. Prentki and M. Veltman (CERN, Geneva). Phys. Letters, 15: 88-90(Mar. 1, 1965).

The CP-violating decay $K_2^0 \rightarrow 2\pi$ is studied, considering the possibility that the CP violation is due to perturbation by some interaction on an otherwise normal weak process. It is pointed out that the semistrong interactions—i.e., SU(3) violating interactions—could be used to explain the decay, and predictions of the proposed model are compared with experimental observations. (M.J.T.)

18859 A THEORY OF T-VIOLATION. F. Salzman and G. Salzmann (Northeastern Univ., Boston). Phys. Letters, 15: 91-4(Mar. 1, 1965).

It is assumed that violation of time reversal invariance (T) does occur; its primary source is proposed to be the electromagnetic interaction of the semi-weakly interacting charged intermediate vector bosons, W^+ and W^-. It is also assumed that weak processes occur through current-current interaction mediated by $W^\pm$ mesons and that CPT invariance holds. The nucleon electric dipole moment induced by this interaction is calculated; the result is found to be consistent with the experimental upper limit on the neutron moment. The ratio of the amplitude for $K_2^0 \rightarrow 2\pi$ to $K_1^0 \rightarrow 2\pi$ is estimated, and the lack of observation of T-violating effects in other experiments is explained. (M.J.T.)

18860 PARITY CONSERVING NON LEPTONIC HYPERON DECAYS IN SU(6). W. Alles and G. Segre. Phys. Letters, 15: 94-6(Mar. 1, 1965).

The parity conserving part of the nonleptonic hyperon decays is examined within the framework of SU(6) symmetry. Eighteen independent amplitudes for the parity conserving hamiltonian, obtained by introducing an orbital angular momentum spurion, are listed, and sum rules are derived from them. (M.J.T.)

18861 SU_6 SYMMETRY AND THE RADIATIVE DECAYS OF BOSONS. S. Badier and C. Bouchiat (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Letters, 15: 96-9(Mar. 1, 1965).

The radiative decays $\rho^0 \rightarrow \pi^0 + \gamma$, $\omega^0 \rightarrow \pi^0 + \gamma$, and $\phi^0 \rightarrow \pi^0 + \gamma$ are studied in the framework of SU(6) symmetry. It is shown that SU(6) symmetry, combined with a definite hypothesis on the symmetry breaking mechanism, yields both the branching ratio $A(\rho^0 \rightarrow \pi^0 + \gamma)/A(\phi' \rightarrow \pi^0 + \gamma)$ and the sign of the ω-ϕ mixing amplitude. Some remarks are made on the radiative decays of the $X^0(950)$ meson in connection with the possible existence of a new additive quantum number. (M.J.T.)

18862 AN APPLICATION OF RELATIVISTIC SU(6) INVARIANCE TO THE THEORY OF WEAK SEMILEPTONIC INTERACTIONS. W. Ruehl (CERN, Geneva). Phys. Letters, 15: 99-101(Mar. 1, 1965).

A relativistic generalization of SU(6) invariance, based on a higher symmetry group containing the inhomogeneous Lorentz group and the SU(3) group, is applied to the theory of weak semileptonic interactions, thus generalizing Cabbibo's theory. SU(6) transformation properties are ascribed to the leptonic current, and the model is applied to meson and baryon decays. (M.J.T.)

18863 THE TRILINEAR MESON-MESON COUPLING AND THE ELECTROMAGNETIC INTERACTION OF MESONS IN A RELATIVISTIC MODEL OF SU(6) SYMMETRY. W. Ruehl (CERN, Geneva). Phys. Letters, 15: 101-4 (Mar. 1, 1965).

Mesons are treated as identical particles, and mesons and photons are assumed to belong to 35-dimensional representations of SU(6) with negative parity. The set of possible invariant couplings is listed. Form factors for the trilinear vertices for photons and pseudoscalar and vector mesons are obtained. Predictions of this model are compared with known experimental results. (M.J.T.)

18864 MULTIMESON RESONANCES AND NUCLEON-NUCLEON INTERACTION. A. Scotti (Universita, Milan) and D. Y. Wong. Phys. Rev., 138: B145-62(Apr. 12, 1965).

Relativistic partial-wave dispersion relations are formulated for elastic nucleon-nucleon scattering. These dispersion relations are integral equations with an inhomogeneous term taken from single-particle exchange contributions. The particles under consideration are π(I = 1, pseudoscalar), η(I = 0, pseudoscalar), ρ(I = 1, vector), ω(I = 0, vector), φ (I = 0, vector), and σ(I = 0, scalar). The existence of a σ meson is not well established. Two possibilities are considered: (i) The σ meson exists, in which case the mass and coupling constants are taken to be two parameters of the present problem. (ii) The σ meson does not exist but the I = 0, J = 0 two-pion continuum is taken into account. This two-pion continuum can be treated as a superposition of

scalar particles with a mass spectrum determined by pion-nucleon and pion-pion interactions. Information on the πN interaction is obtained from πN scattering data, while the S-wave $\pi\pi$ interaction is represented with a relativistic scattering-length approximation. In addition to the $\pi\pi$ scattering length, a cutoff on the two-pion spectrum is introduced. Thus two parameters are introduced in either (i) or (ii). Aside from the masses and coupling constants of the particles mentioned, a cutoff parameter is needed for each of the vector mesons ρ, ω, and φ. These are taken to be coefficients in an exponentially decreasing factor suggested by the Regge-pole behavior of composite particles. A total of twelve adjustable parameters is used and a search program is formulated to fit 560 pp and np data collected by the Livermore group ranging from 9.68 to 388 Mev. In both cases (i) and (ii), a fit is obtained with a goodness to fit value of approximately 8%, meaning that the χ^2 is ~548 if the uncertainty inherent in the theory is assumed to be 8%. (auth)

18865 CALCULATION OF $N^{*++} - N^{*-}$ MASS DIFFERENCE BY S-MATRIX METHODS. S. N. Biswas, S. K. Bose, and L. K. Pande (Univ. of Delhi). Phys. Rev., 138: B163-4(Apr. 12, 1965).

The electromagnetic mass difference between the N^{*++} (pion-nucleon $^3/_2$ resonance with $T_3 = +^3/_2$) and N^{*-} ($T_3 = -^3/_2$) is calculated using the recent method of Dashen and Frautschi. The calculated mass difference is $(M_{N^{*}_{++}} - M_{N^{*}})$ = -2.8 Mev. The experimental value is $(M_{N^{*}_{++}} - M_{N^{*}}) = 0.6 \pm 5$ Mev. (auth)

18866 PROTON-PROTON ELASTIC SCATTERING INVOLVING LARGE MOMENTUM TRANSFERS. G. Cocconi (Cornell Univ., Ithaca, N. Y.), V. T. Cocconi, A. D. Krisch, J. Orear, R. Rubinstein, D. B. Scarl, B. T. Ulrich, W. F. Baker, E. W. Jenkins, and A. L. Read. Phys. Rev., 138: B165-72(Apr. 12, 1965).

Twenty-nine proton-proton differential elastic cross sections for lab momenta p_0 from 11 to 31.8 Bev/c, at four-momentum transfers squared, $-t$, from 2.3 to 24.4 $(Bev/c)^2$, were measured at the Brookhaven alternating gradient synchrotron. The circulating proton beam impinged upon a thin CH_2 internal target. Both scattered protons from p-p elastic events were detected by scintillation-counter telescopes which were placed downstream from deflection magnets set at the appropriate angles to the incident beam. The angular correlation of the protons, their momenta, and the coplanarity of the events were determined by the detection system. The results show that at high momentum transfers the differential cross section, $d\sigma/dt$, depends strongly upon the energy; for $-t = 10\,(Bev/c)^2$, the value of $d\sigma/dt$ at $p_0 = 30$ Bev/c is smaller by a factor ~1000 than at $p_0 = 10$ Bev/c. At all energies, $d\sigma/dt$ falls rapidly with increasing $|t|$ for scattering angles up to about 65° (c.m.), while in the range from 65 to 90° the cross section falls only by a factor of about 2. The smallest cross section measured was 9×10^{-37} cm^2 sr^{-1} (c.m.), at $p_0 = 31.8$ Bev/c and $-t = 20.4$ $(Bev/c)^2$; this is about 3×10^{-12} of the zero-degree cross section at the same energy. (auth)

18867 ELECTROMAGNETIC INTERACTIONS OF HIGH-ENERGY MUONS. P. D. Kearney and W. E. Hazen (Univ. of Michigan, Ann Arbor). Phys. Rev., 138: B173-8 (Apr. 12, 1965).

The production of knock-on electrons and of electron pairs by muons of mean energy > 50 Bev was measured from cloud-chamber photographs of soft showers produced in lead plates. The cloud chamber was operated at a depth of 8.42×10^4 g/cm^2 underground. About half the date were taken while the cloud chamber was tilted 66° in order to favor observation of the high-average-energy muons that come in at large zenith angle. The energies of the electrons that initiated the showers were obtained from an experimental calibration. The shower energies that were studied extended from 85 to about 10^4 Mev. The observed frequency is compared with the expected frequency calculated from the results of Bhabha for knock-on electrons and those of Zapolski and of Murota, Ueda, and Tanaka for electron pairs. The agreement is satisfactory except for knock-on electrons in the region of 10^9 ev, where the predicted frequency appears to be significantly lower than the observed frequency. (auth)

18868 PROTON-ANTIPROTON ANNIHILATIONS INTO TWO MESONS. I. Richard Lapidus (Stevens Inst. of Tech., Hoboken, N. J.) and Joseph M. Shpiz. Phys. Rev., 138: B178-86(Apr. 12, 1965).

Proton-antiproton annihilation cross sections into two mesons are calculated assuming that contributions from the diagrams with a single intermediate meson dominate. Unitary symmetry and ω-ϕ mixing together with the total rates and cross sections for annihilation into two pseudoscalar mesons are used to obtain estimates of the derivative coupling constants for the ρ and Y mesons. (The Y meson is the member of the vector octet which is coupled to the hypercharge current.) The model is thus able to account for the annihilation into two pions and into two kaons, but yields results which are generally too large by an order of magnitude for the other two-meson final states of $p\bar{p}$ annihilations. It is pointed out that if the $\omega\rho\pi$ coupling constant, which is estimated from the 3π width of the ω, were smaller, and if the pseudoscalar meson intermediate states were neglected, then the model would yield a reasonably good description of the experiments. (auth)

18869 FREUND-KARPLUS NATURAL BOUNDARY. John H. Schwarz (Univ. of California, Berkeley). Phys. Rev., 138: B187-9(Apr. 12, 1965). (UCRL-11755)

The question of the existence of the Freund-Karplus natural boundary in the two-body scattering amplitude is examined. A possibility not previously discussed of a cancellation of singularities is considered, but it is found to be insufficient to prevent the natural boundary from being present. (auth)

18870 ENERGY-DEPENDENT PION-NUCLEON PHASE-SHIFT ANALYSIS. L. David Roper (Univ. of California, Livermore), Robert M. Wright, and Bernard T. Feld. Phys. Rev., 138: B190-210(Apr. 12, 1965). (UCRL-7904)

Energy-dependent pion-nucleon phase-shift analyses were carried out in the energy ranges 0–50, 0–100, 0–350, 0–700, and 300–800 Mev. An outline of the procedure is given. The results obtained with all available data are presented. The best solution in the 0–350-Mev range is obtained by starting from Donnachie, Hamilton, and Lea's predicted phases, although the final results differ widely from the input. The best solution obtained in the 0–700-Mev range contains three resonances: in the P_{33} state at 193 Mev, the P_{11} state at approximately 585 Mev, and the D_{13} state at 638 Mev. The last two are strongly absorptive. A good solution was obtained without the P_{11} phase shift actually going through 90°, but it must be large (about 80°) at 700 Mev. The 0–100-, the 0–350-, and the 0–700-Mev solutions are consistent with each other in the large phases. The P_{11}, P_{13}, and P_{31} phases cannot be precisely determined by using only the 0–50-Mev data. (auth)

18871 $K_2 \rightarrow \pi^+ + \pi^-$ AND THE QUESTION OF BOSE STATISTICS FOR PIONS. S. A. Bludman (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 138: B213-15(Apr. 12, 1965).

K_2 decay into $\pi^+ + \pi^-$ is possible in a CP-invariant way if the $\pi^+\pi^-$ wave function contains a term antisymmetric in $\pi^+\pi^-$ exchange. This possibility requires a small violation of Bose symmetry for identical particles (extended to a particle-antiparticle pair) which, because the evidence for pion Bose statistics has consisted in the absence until recently of $K_2 \rightarrow 2\pi$, are consistent with present experimental data. Irrespective of any question of Bose statistics, if PC is conserved, $K_2 \rightarrow \pi^0 + \pi^0$ is forbidden. The absence or presence of this latter decay will thus discriminate between the theory discussed and theories in which PC is violated for the K-π system either in the dynamics or because of environmental effects. The contribution of an antisymmetric $\pi^+\pi^0$ state to $K_2\pi^+$ decay is considered assuming the same statistical mixing E for the $\pi^+\pi^0$ final state in K^+ decay as for the $\pi^+\pi^-$ state in K^0 decay. If $\Delta T = ^1/_2$ amplitudes dominate, this antisymmetric $\pi^+\pi^0$ state contributes negligibly to the $K^+_{2\pi}$ decay rate, which is therefore still large compared with what might be expected from electromagnetic

corrections to an otherwise exact $\Delta T = 1/2$ rule. If $\Delta T = 1/2$ amplitudes dominate, then $E = 1.5 \times 10^{-3}$, but if $\Delta T = 1/2$, $3/2$, and $5/2$ amplitudes are comparable, then a value as large as $E = 0.07$ is possible. A short critical review of what is called for in order to test pion Bose statistics in the light of the recent experiment of Christensen et al., and remarks on the theoretical consequences of impure Bose statistics are included. (auth)

18872 POSITRON LIFETIME SPECTRA IN THE NOBLE GASES. P. E. Osmon (Columbia Univ., New York). Phys. Rev., 138: B216-18(Apr. 12, 1965).

Positron lifetime spectra were measured in helium, neon, argon, krypton, and xenon at pressures of a few atmospheres. The annihilation rates of the free positrons are found to be time-dependent. Physical reasons, based on the strong correlation between energy and age of a positron, are suggested for this time dependence. Three parameters describing the main features of the free-positron spectrum are separated from the data, for each gas, and tabulated. (auth)

18873 A NEW DYNAMICAL MODEL FOR MESON STATES. Daniel Z. Freedman (Imperial Coll. of Science and Tech., London). Phys. Rev., 138: B218-22(Apr. 12, 1965).

Reasons are advanced for considering the effect of inelastic coupling to the vector-vector state on the meson states occurring in pseudoscalar-pseudoscalar scattering. A model based on the angular-momentum properties of the box graph containing 2 vector mesons in the intermediate state is developed. In the dynamics of the model the elementary vector-meson octet disappears, and a vector-octet Regge trajectory is generated. A Pomeranchuk trajectory is generated in the singlet amplitude. The slopes of the trajectories are in quite reasonable agreement with experimental indications. The model predicts a $\rho\pi\pi$ coupling constant a factor of 2 or 3 above the experimental value and about the same as the value predicted by bootstrap models. The model shares with bootstrap models the feature that SU_3 symmetry is predicted as a consequence of dynamical self-consistency. The basic effect is expected to be important in more conventional dynamical schemes, and suggestions are made for further work. (auth)

18874 PROPERTIES OF "35" SPIN-$1/2$ BARYON RESONANCES IN A MODEL WITH BROKEN SU(3). Roger F. Dashen (California Inst. of Tech., Pasadena) and David H. Sharp. Phys. Rev., 138: B223-5(Apr. 12, 1965).

The properties of a set of $J = 1/2^+$ resonances appearing in a 35-dimensional representation of SU(3), as proposed by Abers, Balázs, and Hara are investigated. A simple dynamical calculation gives an estimate for the mass differences within the supermultiplet. The matrix elements for the SU(3) allowed decays into meson plus resonance are given in terms of one parameter and the SU(3)-violating matrix elements for decay into meson plus baryon are given by two parameters. (auth)

18875 APPROXIMATE FORMULA FOR A REGGE TRAJECTORY WITH RIGHT-HAND CUT AND ITS APPLICATION. M. M. Islam (Brown Univ., Providence). Phys. Rev., 138: B226-32(Apr. 12, 1965).

A general ansatz for the imaginary part of a Regge trajectory, with only a right-hand cut is derived using conformal mapping and threshold behavior. The dispersion relation and a three-parameter approximation of this ansatz are used to obtain an analytical formula for the trajectory. If the Pomeranchuk trajectory has no left-hand cut, then application of this formula shows that f^0 does not lie on this trajectory. Further, it is found that $\alpha_P(\pm\infty) > -1$ and $\gtrsim 0$. Applying the formula to f^0 and ρ, it is concluded that, if the approximation is good, then the Regge trajectories corresponding to these resonances must have left-hand cuts. (auth)

18876 VECTOR-PSEUDOSCALAR RESONANCES. Mahiko Suzuki (Tokyo Univ.). Phys. Rev., 138: B233-42 (Apr. 12, 1965).

Higher meson resonances are investigated in simple dynamical models based on the SU(3) symmetry with and without recourse to the A-conservation rule. The models consider the vector-pseudoscalar systems as their main configurations. The predicted level schemes are rather sensitively dependent on the trilinear self-coupling of the octuplet vector mesons. One of the main results is that there should exist a low-lying 1^+ singlet and a 1^+ octuplet probably above it. The existing higher meson resonances are tentatively assigned to the levels predicted. (auth)

18877 HIGH-ENERGY LIMIT OF PION-NUCLEON TOTAL CROSS SECTION. Masao Sugawara and Arnold Tubis (Purdue Univ., Lafayette, Ind.). Phys. Rev., 138: B242-5(Apr. 12, 1965).

A simple estimate of the high-energy limit of the pion-nucleon total cross section is given in terms of the mass and the width of the 33 resonance and the S-wave pion-nucleon scattering lengths. The underlying assumptions are that the forward elastic (charge-nonexchange) scattering amplitude satisfies the usual (once-subtracted) dispersion relation, and that the scattering becomes dominantly absorptive in the high-energy region. This estimate gives 23 mb as the limit of the total cross section, which is in close agreement with what one obtains from a simple extrapolation of the available high-energy cross sections. The analysis strongly suggests that a simple correlation exists between a pronounced low-energy resonance and the high-energy limit of the scattering amplitude. (auth)

18878 SPONTANEOUS MASS SPLITTING IN A BOOTSTRAP MODEL. David Y. Wong (Univ. of California, San Diego, La Jolla). Phys. Rev., 138: B246-7(Apr. 12, 1965).

A model is constructed in which all members of the vector octet (φ', K^*, ρ) appear as two-body bound states of themselves, i.e., $\varphi' \to (K^*\bar{K}^*)$, $K^* \to (\varphi' K^*, \rho K^*)$, $\rho \to (\rho\rho, K^*\bar{K}^*)$. The two-body interaction is represented by a fixed pole of the T matrix with residues related by Clebsch-Gordan coefficients derived from the ⑩ representation of SU_3. For a given position of the pole, the over-all strength of the residue is adjusted so that $m_{\varphi'} = m_{K^*} = m_\rho$ is a solution of the problem (m stands for the masses of the bound states as well as the masses of the free particles). Keeping the position and residues of the potential poles unchanged, the existence of a self-consistent solution with mass splitting is investigated. It is found that within a certain range of the pole position, there exists one and only one solution with nondegenerate masses, and outside of that range of the pole position, there exists none. A comparison between the nondegenerate solution and the Gell-Mann-Okubo mass formula is made. It is also noted that the deviation of the coupling constants from the SU_3 values is very small (<2%) even when the mass splitting is quite sizable. (auth)

18879 MANY-BODY PROBLEM FOR COMPOSITE PARTICLES. Harry L. Sahlin and Judah L. Schwartz (Univ. of California, Livermore). Phys. Rev., 138: B267-73(Apr. 12, 1965). (UCRL-12135-T)

A formalism for treating the many-body problem of composite particles is presented for the case of composite particles consisting of two fermions. Commutation relations for composite-particle operators are derived, as well as a sum rule satisfied by the composite-particle Green's function. In an approximation that shuts off the interactions between composite particles in a consistent manner, the dynamical equation for the one-composite-particle Green's function is solved and the distribution function for the composite particles obtained. Possible applications to real systems are discussed. (auth)

18880 P STATES OF SYSTEMS OF THREE COULOMBIC PARTICLES. Charles W. Scherr and Milos Machacek (Univ. of Texas, Austin). Phys. Rev., 138: A371-81(Apr. 19, 1965).

Center-of-mass coordinates are employed to determine the dependence on the masses of the particles of the energy and other physical properties of systems with three Coulombic particles (two identical). No adiabatic approximation is needed since the hamiltonian with the exact mass dependence is used in the variational problem. The total angular momentum of the particles is quantized to unity. Both permutational symmetry states of odd parity are treated. The computations cover the entire range of the

mass ratio as well as several different charges of the particles. In most cases the energies obtained are either the lowest yet found or the first to be reported. (auth)

18881 DETERMINATION OF THE $\Sigma^+ \to p + \gamma$ DECAY RATE. M. Bazin, H. Blumenfeld, U. Nauenberg, L. Seidlitz, and C. Y. Chang (Princeton Univ., N. J.). Phys. Rev. Letters, 14: 154-6(Feb. 1, 1965). (PPAD-527-E)

The branching ratio $\Sigma^+ \to p + \gamma/\Sigma^+ \to p + \pi^0$ was determined to be $0.37 \pm 0.08 \times 10^{-2}$ by analysis of events observed in the stopping of mesons (K^-) in a hydrogen bubble chamber. (D.C.W.)

18882 MAXIMAL UNITARY GROUP FOR THE QUARK MODEL. S. Okubo and R. E. Marshak (Univ. of Rochester, N. Y.). Phys. Rev. Letters, 14: 156-60(Feb. 1, 1965).

It is shown that there is a unitary gauge group much larger than W(6) = U(6) ⊗ U(6) under which the scalar or pseudoscalar four-fermion interaction is invariant for a triplet of quark fields. This group can be obtained from an infinite-dimensional Lie algebra. (D.C.W.)

18883 ELECTROMAGNETIC MASS DIFFERENCES. L. A. Radicati, L. E. Picasso, D. P. Zanello, and J. J. Sakurai (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 14: 160-3(Feb. 1, 1965).

The various sum rules proposed for the medium-strong and electromagnetic mass differences of hadrons are discussed, and some additional sum rules are proposed. (D.C.W.)

18884 SU(6) ⊗ O(3) STRUCTURE OF STRONGLY INTERACTING PARTICLES. K. T. Mahanthappa, and E. C. G. Sudarshan (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 14: 163-6(Feb. 1, 1965). (NYO-3399-08)

The invariance of the strong interactions under SU(6) ⊗ O(3) is postulated, where O(3) is a group of rotations in the three-dimensional space, independent of the spin group $SU(2)_s$ contained in SU(6). Multiplet assignments, meson-baryon coupling, electromagnetic properties, and the mass formula are considered. (D.C.W.)

18885 SU(6) AND NONLEPTONIC HYPERONIC DECAYS. P. Babu (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Letters, 14: 166-8(Feb. 1, 1965).

Sum rules for the decay amplitudes $\Lambda \to N + \pi$, $\Sigma \to N + \pi$, and $\Xi \to \Lambda + \pi$ are obtained under the assumption that the Hamiltonian responsible for nonleptonic weak decays of hyperons transforms like a member of the adjoint representation of SU(6). Both parity-conserving and parity-violating amplitudes are considered. (D.C.W.)

18886 HEAVY ELECTRONS AND MUONS. F. E. Low (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 14: 238-9(Feb. 15, 1965). (MIT-2098-110)

Three possible electron couplings to bosons and electrons are discussed in which a breakdown of quantum electrodynamics might be observed. (D.C.W.)

18887 MESON COUPLINGS IN THE INTRINSICALLY BROKEN U(6) SYMMETRY SCHEME. K. Bardakci, J. M. Cornwall, P. G. O. Freund, and B. W. Lee (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 14: 264-7(Feb. 22, 1965).

The implications of the groups U(6) and W_6 = U(6) ⊗ U(6) for trilinear meson interactions are discussed. It is shown that good values for parameters like the $\omega\rho\pi$, $\varphi\rho\pi$, $K^*K^*\pi$, and $K^*\rho K$ coupling constants are obtained from U(6) symmetry. The decay rates for $\omega \to 3\pi$ and $K^* \to K + 2\pi$ are calculated in agreement with experiment, using these parameters, and a selection rule forbidding $\varphi \to \rho + \pi$ is obtained. A method for the construction of interactions that are both U(6) and Lorentz invariant is outlined, together with a method for handling the intrinsic symmetry breaking due to kinetic energy effects. (D.C.W.)

18888 RELATIVISTIC, CROSSING-SYMMETRIC, SU(6)-INVARIANT S-MATRIX THEORY. M. A. B. Beg and A. Pais (Rockefeller Inst., New York). Phys. Rev. Letters, 14: 267-70(Feb. 22, 1965).

The construction of an S-matrix theory that is fully covariant, crossing symmetric, and SU(6) invariant is outlined. (D.C.W.)

18889 NONEQUIVALENCE OF THE ONE-CHANNEL N/D EQUATIONS WITH INELASTIC UNITARITY AND THE MULTICHANNEL ND^{-1} EQUATIONS. Myron Bander, Philip W. Coulter, and Gordon L. Shaw (Stanford Univ., Calif.). Phys. Rev. Letters, 14: 270-2(Feb. 22, 1965).

Considering a set of coupled two-body channels, it is shown that the amplitude A obtained with the one-channel ND^{-1} formalism is, in general, not equal to the amplitude A_{11} calculated by the multichannel ND^{-1} equations. A sufficient condition for agreement of the two calculations is obtained. It is also shown that there are no poles of the S-matrix on the physical sheet for complex values of S. (D.C.W.)

18890 MAGNETIC MOMENTS OF THE BARYON SUPERMULTIPLET 21 × 6 IN U(6) ⊗ U(6). M. A. Rashid (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev. Letters, 14: 272-3(Feb. 22, 1965).

The magnetic moments of the 126 members of the supermultiplet were written in terms of the proton magnetic moment assuming that the effective electromagnetic current associated with this supermultiplet transforms like the U-spin scalar in the 35-dimensional representation obtained from 6 × 6* by going to the SU(6) limit. The transition moments between the various members which are allowed by the conservation laws were also obtained. (D.C.W.)

18891 DECAYS OF $F_{\frac{5}{2}}$ RESONANCES. David M. Brudnoy (Univ. of Minnesota, Minneapolis). Phys. Rev. Letters, 14: 273-5(Feb. 22, 1965).

The couplings governing the principal decay modes of the $N^+_{\frac{5}{2}}$ (1688) and $Y^*_{\frac{5}{2}}$ (1815) resonances are calculated, together with the decay widths. (D.C.W.)

18892 ELECTROMAGNETIC Ξ*(1530) MASS DIFFERENCE. G. M. Pjerrou, P. E. Schlein, W. E. Slater, L. T. Smith, D. H. Stork, and H. K. Ticho (Univ. of California, Los Angeles). Phys. Rev. Letters, 14: 275-9(Feb. 22, 1965).

The mass difference $(\Xi^{*-} - \Xi^{*0})$ was determined using the interactions $\kappa^- + p \to \kappa^0 + \pi^+ + \Xi^-$, $\kappa^+ + \pi^- + \Xi^0$, and $\kappa^+ + \pi^0 + \Xi^-$. The result is compatible with predictions of unitary symmetry. (D.C.W.)

18893 SEARCH FOR LEPTON-PAIR DECAYS OF MESONIC RESONANCES. Angela Barbaro-Galtieri, and Robert D. Tripp (Univ. of California, Berkeley). Phys. Rev. Letters, 14: 279-83(Feb. 22, 1965). (UCRL-11891)

An attempt was made to observe lepton pairs originating from meson resonances in the interaction $k^- + p \to \Lambda + 2$ prongs at 2.45, 2.60, and 2.70 Bev/c. No clear evidence of lepton-pair production was obtained. Upper limits for the lepton-pair decay rates of ω and φ were determined. (D.C.W.)

18894 DECAY OF BARYON RESONANCES IN THE SPIN AND UNITARY-SPIN INDEPENDENCE MODEL. Ruggero Ferrari (Scuola Normale Superiore, Pisa, Italy) and Michiji Konuma. Phys. Rev. Letters, 14: 378-80 (Mar. 8, 1965).

Relations are presented between the decay widths of the N*(1238), Y^*_1(1385), and Ξ*(1530) in the spin and unitary-spin independence model. (D.C.W.)

18895 VELOCITY-DEPENDENT NUCLEON-NUCLEON POTENTIALS. A. E. S. Green and R. D. Sharma (Univ. of Florida, Gainesville). Phys. Rev. Letters, 14: 380-3 (Mar. 8, 1965).

Nucleon-nucleon potentials with velocity-dependent terms are described, based on pseudoscalar and five-vector meson fields. The potentials are compared with potentials proposed in phenomenological analyses of the nucleon-nucleon interaction. (D.C.W.)

18896 TWO-PION DECAY OF THE K^0_2 MESON. W. Galbraith (Atomic Energy Research Establishment, Harwell, Berks, Eng.), G. Manning, A. E. Taylor, B. D. Jones, J. Malos, A. Astbury, N. H. Lipman, and T. G. Walker. Phys. Rev. Letters, 14: 383-6(Mar. 8, 1965).

The branching ratio for the $K_2^0 \rightarrow \pi^+ + \pi^-$ mode was determined to be $2.08 \pm 0.35 \times 10^{-3}$ in an experiment in which the two-pion mode was clearly distinguished from the background of three-body decays. It was concluded that the decay rate is not proportional to the square of the total energy of the meson (K_2^0). (D.C.W.)

18897 SUBMILLIMETER ČERENKOV WAVE GENERATION IN SOLIDS. William Honig (Loral Electronic Systems, Bronx, N. Y.). Proc. IEEE (Inst. Elec. Electron. Engrs.), 53: 182(Feb. 1965).

A method is proposed for the production of submillimeter Cherenkov waves. High-energy electrons are generated by an electric field across an InSb rod, the surface of which is coated with a material in which the conditions for Cherenkov emission are satisfied. The Cherenkov waves are directed through a Cherenkov coupler or conical reflector, yielding a plane wave. Energy is reflected back into the wave generation region by reflection structures. (D.C.W.)

18898 A KLEIN-GORDON MODEL PARTICLE. J. L. Synge (Dublin Inst. for Advanced Studies). Proc. Roy. Soc. (London), Ser. A, 283: 14-17(Jan. 5, 1965).

A certain class of solutions of the Klein-Gordon equation, free of singularities and involving an arbitrary constant β in addition to the mass-parameter μ is described. Examination of the field suggests that it might be interpreted as a model particle with half life β and radius $r_1 = (\beta/\mu)^{\frac{1}{3}}$. (auth)

18899 THE COVARIANT THEORY OF STRONG INTERACTION SYMMETRIES. A. Salam, R. Delbourgo, and J. Strathdee (Imperial Coll. of Sci. and Tech., London). Proc. Roy. Soc. (London), Ser. A, 284: 146-58(Feb. 9, 1965).

A classification of particles is suggested, based on a $\tilde{U}$ (12) symmetry scheme. This is a relativistic generalization of the U(6) symmetry. The spin $\frac{1}{2}$ and $\frac{3}{2}$ baryons are each described by 20-component spinors which satisfy Bargmann–Wigner equations and belong to the 364 representation of the $\tilde{U}(12)$ group while the vector and pseudoscalar mesons belong to the representation 143. The procedure for writing fully relativistic form factors is worked out in detail for baryon–meson and meson–meson cases. The conventional U(6) results can be recovered by projecting to the positive energy subspace in the rest system for each particle. To any irreducible representation of the U(6), there corresponds one irreducible representation of $\tilde{U}(12)$ and vice versa. (auth)

18900 A BOOTSTRAP CALCULATION FOR THE MASS OF THE π-π (T = 0, l = 0) ANTIBOUND STATE. S. Ciulli and Gr. Ghika (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 927-38(1964).

Bootstrap calculations can be performed not only for poles on the physical Riemann sheet but also for poles lying on the second Riemann sheet (resonances and antibound states). A bootstrap calculation of the mass of the ABC Particle (T = 0, l = 0) is performed. It is assumed that this particle is a second Riemann sheet pole located on the real axis very near the elastic threshold. The Chew pole approximation is considered the crossing relations being then used only on the line s = 0. (auth)

18901 THE REGGE BEHAVIOUR FOR A CLASS OF NONLOCAL POTENTIALS. Yuan-ben Dai. Sci. Sinica (Peking), 14: 47-61(Jan. 1965).

It is proved that for a class of nonlocal potentials the matrix element $S(\lambda,k)$ considered as a function of the angular momentum variable λ is meromorphic in the region $\mathrm{Re}\,\lambda > 0$ and that $(S(\lambda,k) - 1)\exp(-i\pi\lambda)$ approaches 0 as λ approaches ∞ along the positive real axis or negative imaginary axis. Under further assumptions, $S(\lambda,k)$ is proved to be meromorphic in the strip $|\mathrm{Im}\,k| < \mu$ in the complex k-plane. Problems concerning the positions of poles are discussed. For this kind of potentials, the Regge poles in the right-half λ-plane do not necessarily lie in the first quadrant. (auth)

18902 PROBLEMS IN THE THEORY OF POINT AND EXTENDED CHARGE PENETRATION THROUGH SUBSTANCES. B. M. Bolotovskii. Tr. Fiz. Inst., Akad. Nauk SSSR, 22: 3-100(1964). (In Russian)

Equations are given for the electromagnetic energy losses of a point charge, a group of point charges, and packets of charge (length ℓ, radius R, charge density ρ), traveling with a velocity v through an electron plasma and matter. The electromagnetic fields are expressed in terms of the scalar and vector potentials ϕ and A. Dispersion relations are drawn from Fourier analysis. For the electron plasma the Vlasov equations are linearized by perturbing the Maxwellian plasma distribution f_0 by a small amount f. If the product of the wave vector k and the Debye radius D is small ($kD \ll 1$) coherent longitudinal waves arise with wavelengths $2\pi v/\omega_0 > D$, where ω_0 is the plasma frequency. Equations derived for the energy loss are compared with results of the Bohm method and with the hydrodynamic approximation. Electromagnetic energy losses to the longitudinal waves over a range > D occur only if $v > v_T/\sqrt{3}$, where v_T is the thermal velocity of the plasma. No energy is lost by transverse waves. Equations for packets of charge are stable only if ℓ and R are considered fixed. If ℓ, $R \ll D$ the packets may be considered as point charges. Otherwise the energy loss is proportional to $(1 + 2\cos(\omega_0\ell/v))$. Interference effects occur, and if the charge packets can give rise to coherent longitudinal waves they are unstable. Matter is characterized by a complex dielectric constant e. The energy losses are characterized by Poynting vectors. Bremsstrahlung and Cherenkov radiation are considered. For a point charge the given calculation is more exact than that published previously. The case of charge traveling in one medium (or void) surrounded by another medium is considered (the problem of charge traveling in a wave guide). For many charges, and for the case where ρ is periodic, interference effects in matter are similar to those in the electron plasma. (TTT)

18903 DEUTERON PHOTOSPALLATION AT MEAN ENERGIES OF GAMMA QUANTA. L. N. Shtarkov. Tr. Fiz. Inst., Akad. Nauk SSSR, 22: 155-221(1964). (In Russian)

Experimental and theoretical studies published to 1961 on the photodisintegration of the deuteron are reviewed. The differential cross section $d\sigma/d\Omega$ (for the proton) was measured over a range of 22 to 160° for gamma energies of 54, 70, 88, 110, 129, and 148 Mev (lab system). Statistical errors are about 10%. The protons were registered by a proportional-counter telescope that could register protons >10 Mev. The deuterium target was heavy water. The experimental results were compared with theoretical calculations considering E1, E3, M1, and M3 transitions. The differential cross section was fit to a curve $d\sigma/d\Omega = a + b\sin^2\Theta + c\cos\Theta + d\sin^2\Theta\cos\Theta$. Below 120 Mev the theoretical and experimental values of a, b, c, and d are in good agreement. No evidence is found for meson(π) effects. Above 120 Mev the experimental values of a and b greatly exceed the theoretical values. The difference might be explained by virtual meson(π) effects, but the effect of higher multipoles should also be considered, since below 120 Mev the disagreements which pointed to meson(π) effects were erased by considering the $^3F_2$ tensor interaction in the final state. (TTT)

18904 NON-LINEAR INTERACTION BETWEEN AN OBLIQUELY INCIDENT PLANE ELECTROMAGNETIC WAVE AND AN ELECTRON BEAM. Hans Wilhelmsson. Trans. Chalmers Univ. Technol., Gothenburg, No. 290, 1-48(1964).

The interaction of an obliquely incident plane wave with an electron beam in an infinitely strong static magnetic field in the direction of the beam is analyzed, using the theory of dynamic nonlinear wave propagation. (D.C.W.)

18905 SCATTERING OF THE NEUTRINO AND ANTINEUTRINO ON A POLARIZED ELECTRON. POLARIZATION OF THE RECOIL ELECTRON. B. K. Kerimov and Yu. I. Romanov. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 5, 79-87(Sept.-Oct. 1964). (In Russian)

Work on neutrino-electron scattering that employs low-order perturbation theory and a weak, mixed (V,A) interaction, in the Born approximation is reported. The hamiltonian for the reactions is written out as a product of lepton

currents and the differential cross section is defined in terms of matrix elements derived earlier. Formulas for longitudinal spin and angular correlation for scattering of longitudinally polarized neutrinos on electrons are then given for the mixed (V,A) interaction. The total cross section is obtained by integrating the differential cross section. From the results it follows that in pure (V– A) weak interaction, neutrino and antineutrino scattering on an electron should occur without change of helicity, that is neutrino spin-flip is forbidden. For the (V + A) variety, spin-reversal must occur. Further calculations show that at very high energies, the recoil electrons will have the same helicity as the incident neutrinos and the reverse of the helicity of incident antineutrinos. It follows that experimental study of (anti)-neutrino scattering on polarized electrons would help in resolving the question of a direct electron-neutrino interaction and verify the different helicity-properties of the electron and muon (anti)-neutrinos. (ATD)

18906 EIGHTFOLD WAY AND THE CLASSIFICATION OF THE STRONGLY INTERACTING PARTICLES. Chong-shou Gao (Peking Univ.). Wu Li Hsueh Pao, 20: 1187-98 (Dec. 1964). (In Chinese)

Two additional postulates of the eightfold way are suggested on the basis of the analysis of experiments: the nonlinear contribution of the isospin T and the hypercharge Y to the mass-splitting is independent of the spin-parity of multiplets; and in all cases where the octet-singlet mixing takes place, nine particles are grouped into a reducible nine-dimensional representation and are represented by a 3×3 matrix. The trace of this matrix appears neither in the zero-order term of the mass relation nor in the production and decay interactions of particles. On the basis of these postulates, the classification of the strongly interacting particles, especially the classification of the scalar mesons and the baryon resonances with higher spins, is further discussed. Some predictions are obtained and compared with experiments. The predictions of scalar mesons are discussed in detail and are compatible with experiments. Finally, the results and the implications of the classification are discussed. (auth)

18907 A NOTE ON THE LOW ENERGY PION-NUCLEON (3.3) PARTIAL WAVE SCATTERING. Chang-chie Tsao, Wai-shen Wang, and Ho-chang Huang (Peking Univ.). Wu Li Hsueh Pao, 20: 1210-15(Dec. 1964). (In Chinese)

An approximate expression for the (3,3) partial wave amplitude is given from the analyticity, unitarity, and threshold behavior considerations, in which only two parameters, namely the coupling constant and resonance level, are introduced. This expression is in good agreement with the experimental data from the threshold up to the pion laboratory kinetic energy of about 350 Mev. In comparison with Chew-Low's result, it gives the variation of $(q^3/\omega)\mathrm{ctg}\,\delta_{33}$ with ω not following a straight line but a curve concave downward. Such an improvement is just required by the experimental data. It is shown that there is some inadequacy concerning analyticity in the Chew-Low's expansion and that this inadequacy has been overcome in the present formulation. (auth)

18908 π-Λ COUPLING CONSTANT AND LOW ENERGY π-Λ $P_{3/2}$ WAVE SCATTERING. Chang-Chie Tsao, Chung-yian Wang, and Ta-san Chan (Peking Univ.). Wu Li Hsueh Pao, 20: 1216-20(Dec. 1964). (In Chinese)

The improved Chew-Low expansion, when applied to π-N (3,3) partial-wave scattering, provided a fit to the experimental data from threshold up to energies above resonance. Its expression contains only two parameters, namely the coupling constant and resonance level. Therefore, it may conversely determine the coupling constant from the resonance data (level and width) and hence the (3,3) phase shifts. The π-Λ $P_{3/2}$ wave is studied by the same method. At the present time the most permissible value of π-Λ resonance width is 50 Mev, from which the π-Λ coupling constant is determined to be $g^2 = 34$ or $f^2 = 0.12$. The results corresponding to other possible values of width are also reported. The calculated phase shifts are believed to be legitimate below center of mass total energy $W \approx 1450$ Mev. (auth)

18909 HIGH-ENERGY SOLUTION OF THE DIRAC EQUATION AND CALCULATION OF THE REGGE POLES. Harald J. W. Mueller (Universitat, Munich). Z. Physik, 183: 402-11(1965). (In German)

It is shown that the Dirac-equation can be solved for a superposition of Yukawa-potentials by a modified perturbation procedure. In particular high-energy asymptotic expansions are obtained for the solutions and the Regge-trajectories. Finally the behavior of the Regge-poles is discussed. (auth)

18910 THE SU_6 CLEBSCH-GORDAN COEFFICIENTS FOR THE REDUCTION OF (35) ⊗ (35) TO (35), AND (56) ⊗ (35) TO (56). Lothar Schuelke (Universität, Heidelberg). Z. Physik, 183: 424-7(1965).

A convenient definition of the basis vectors of SU_6 representations is given. The most important Clebsch-Gordan coefficients are calculated. (auth)

18911 RELATIVISTIC KINEMATICS. A Guide To the Kinematic Problems of High-Energy Physics. R. Hagedorn. Lecture Notes and Supplements in Physics. New York, W. A. Benjamin, Inc., 1964. 174p. $9.00 (cloth); $4.95 (paperback).

A series of lectures is presented on relativistic kinematics, including discussions of Lorentz transformations and invariants, system of units, transformation of differential cross sections and Jacobian determinants, variables and coordinate systems used in elastic scattering, phase-space considerations, relativistic notation, and precession of the polarization of spin-$\frac{1}{2}$ particles moving in an electromagnetic field. (M.J.T.)

18912 DISPERSION RELATIONS AND THEIR CONNECTION WITH CAUSALITY. Course XXIX. Proceedings of the "Enrico Fermi" International School of Physics, Varenna, Italy, 15th July–3rd August, 1963. E. P. Wigner, ed. New York, Academic Press, 1964. 272p.

Separate abstracts were prepared for the seven papers included. (D.C.W.)

For abstracts of individual lectures see: 18620, 18913, 18914, 18915, 18916, 18917, and 18918.

18913 THE PROOF OF DISPERSION RELATIONS. M. Froissart (CEN, Saclay, France). p.1-39 of "Dispersion Relations and Their Connection with Causality." New York, Academic Press, 1964.

The general approach to the proof of dispersion relations is outlined. Reduction formulas are derived, together with the Jost-Lehmann-Dyson formula, which is applied to forward dispersion relations. Nonforward dispersion relations are also treated. (D.C.W.)

18914 CAUSALITY, R-MATRIX, AND COLLISION MATRIX. E. P. Wigner (Princeton Univ., N. J.). p.40-67 of "Dispersion Relations and Their Connection with Causality." New York, Academic Press, 1964.

The R-matrix theorem is proved, considering systems which can be described by the usual Schrödinger equation in configuration space. A second proof of the theorem is presented, considering the principle of phenomenological causality and relativistic energies. The collision matrix is derived from the R-matrix, and the singularities of the collision matrix are studied. Analytical identities of the collision matrix are derived, and contraction of the collision matrix below thresholds is considered. (D.C.W.)

18915 DISPERSION RELATIONS AND APPLICATIONS. D. Y. Wong (Univ. of California, La Jolla). p.68-96 of "Dispersion Relations and Their Connection with Causality." New York, Academic Press, 1964.

The three main approaches to the study of the analytic structure of the scattering amplitude are reviewed, based on causality, perturbation and potential theory, and unitarity and crossing relations. The π-N and N-N scattering problems are discussed, using the N/D equations, to demonstrate the usefulness of dispersion relations. The relation of the electromagnetic form factors and the π-N and N-N processes is considered; and it is shown that, under some simple assumptions, unitarity and crossing impose some symmetry structure on interactions involving strange and non-strange particles. (D.C.W.)

18916 THE NONRELATIVISTIC ANGULAR-MOMENTUM PLANE. R. G. Newton (Indiana Univ., Bloomington). p.97-134 of "Dispersion Relations and Their Connection with Causality." New York, Academic Press, 1964.

The behavior of the S-matrix in the angular momentum plane is investigated. The poles of the S-matrix and their motion are studied. Particles with spin and many channels are also considered, together with the three-body problem. (D.C.W.)

18917 PRODUCTION AMPLITUDES. P. V. Landshoff (Cambridge Univ., Eng.). p.135-66 of "Dispersion Relations and Their Connection with Causality." New York, Academic Press, 1964.

Production amplitudes are studied with consideration of analytic properties, partial-wave amplitudes, higher amplitudes, and asymptotic behavior. (D.C.W.)

18918 HIGH-ENERGY SCATTERING AND DISPERSION THEORY. R. Oehme (Univ. of Chicago). p.167-256 of "Dispersion Relations and Their Connection with Causality." New York, Academic Press, 1964.

A survey on the application of the concepts of dispersion theory to high-energy scattering is presented. 74 references. (D.C.W.)

18919 PROTON-PROTON ELASTIC SCATTERING AT 2 Bev. Eugene Robert Leach (Ohio Univ., Athens). 65p. (CONF-640406-3)

From American Physical Society, Ohio Section, Spring Meeting, Cleveland.

A 20-in hydrogen bubble chamber was exposed to a 2.0-Bev proton beam. The missing mass distribution, the chi (goodness of fit parameter) square distribution, and the differential cross section were obtained. A polynomial fit of the experimental scattering data and the optical model were both used to theoretically calculate the differential cross section; the results of the calculations were compared with the experimental data. (D.C.W.)

Field Theory and Quantum Mechanics

Refer also to abstract 18840.

18920 (JINR-P-1934) O LOKAL'NOSTI TEORII POLYA PO NEKOMMUTIRUY-USHCHIM KOORDINATAM. (On the Localizability of a Field Theory With Respect to Noncommuting Coordinates). M. I. Shirokov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 13p. Dep.(mn).

A certain class of coordinate operators r_μ are considered. These operators are different from the usual operator x_μ but, in some sense, are close to it. The theory of the self-interacting scalar field of the ϕ^3 type is taken. It is shown that the requirement for the interaction to be local with respect to the eigenvalues of a coordinate operator is consistent with the unitarity condition and the translational-Lorentz invariance of the theory only in the case of the operator x_μ. (auth)

18921 (JINR-P-1935) DVUMERNAYA RELYATIVISTSKAYA MODEL KVANTOVOI TEORII POLYA BEZ ULTRAFIOLETOVYKH RASKHODIMOSTEI. (A Two-Dimensional Model of Quantum Field Theory without Ultraviolet Divergences). M. K. Volkov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). [1964]. 12p. Dep.(mn).

The polarization operator and the scalar and the spinor Green function were investigated in the two-dimensional case. The calculations made according to perturbation theory with an expansion in Δm, the nucleon mass difference in two possible states, showed that the quantities under study are finite in the two-dimensional case and the model is free from ultraviolet divergences. (auth)

18922 (NP-14766) K TEORII DVIZHENIYA ZARYAZHENNYKH CHASTITS V PERIODICHESKIH POLYAKH. (On the Theory of Charged Particle Motion in the Periodic Fields). A. A. Sharshanov (Akademiya Nauk Ukrainskoĭ SSR. Fiziko-Tekhnicheskii Institut, Karkov). 1963. 15p. Dep.(mn).

Differential equations with periodic coefficients were developed for the theory of charged particle motion in periodic fields. (R.V.J.)

18923 (NP-14821) LECTURES ON GAUGE TRANSFORMATIONS IN QUANTUM FIELD THEORY. Matscience Report 34. Jerzy Lukierski (Institute of Mathematical Sciences, Madras (India)). [1964]. 122p. Dep.(mn).

Notes are presented from a series of lectures on classical and quantum-theoretical analyses of the problems of gauge transformations. The treatment is not restricted to the linear theory. One classical gauge parameter is found to lead to an infinite set of gauge functions in the quantum field theory. (T.F.H.)

18924 (UCRL-11346) NOTES ON HOMOLOGY AND ITS APPLICATION TO ANALYTIC S-MATRIX THEORY. Rudolph C. Hwa and Vigdor L. Teplitz (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 25, 1964. Contract W-7405-eng-48. 73p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The application of the methods of algebraic topology to the evaluation of certain integrals appearing in S-matrix theory is reviewed. Introductory material is included, in an attempt to make the subject accessible without prior knowledge of algebraic topology. Proofs of theorems are omitted but, wherever possible, examples have been included. (auth)

18925 "POST-PAULI APPROXIMATION" AND ITS STATISTICAL INTERPRETATION. Wanda Hanus (Nicholas Copernicus Univ., Torun, Poland). Acta Phys. Polon., 26: 1181-95(Dec. 1964).

The generalized Pauli formalism uniformly treating relativistic corrections of the first and second orders was derived from the Dirac theory (without using the Foldy-Wouthuysen transformation). The necessary hermitization of the Hamiltonian was performed by recurring to physical arguments, leading to a unique form of the correct wave equation. The statistical interpretation of this equation is given. This appears possible on omission of some terms resulting from the Dirac expressions for the charge and current densities. The omitted terms fulfil separately the continuity equation and yield no contribution to the total charge; their physical meaning is discussed. (auth)

18926 SPIN AND GRAVITATION. Heinz Pagels (Stanford Univ., Calif.). Ann. Phys. (N. Y.), 31: 64-87(Jan. 1965).

The presence of a gravitational or electromagnetic field can be regarded as altering the symmetries of flat spacetime in such a way that the group of translations for states with charge and spin is no longer Abelian, the displacement operator obeying $i[D_\alpha, D_\beta] = eF_{\alpha\beta} - \frac{1}{4}\sigma_{\lambda\epsilon}R^{\lambda\epsilon}_{\alpha\beta}$. Furthermore, just as invariance under gauge transformations implies current conservation, invariance under general coordinate and general similarity transformations implies that the stress-energy tensor must satisfy $T^{\alpha\beta}_{|\beta} = 0$ and $(T^{\alpha\gamma}|^\delta - T^{\alpha\delta}|^\gamma)_{|\alpha} = 0$, ten conditions which lead to the Einstein equations. It is also possible to construct the gravitational analog of the electromagnetic current, $J_\alpha = (\kappa/2)\sigma_{\lambda\delta}T^{\lambda|\delta}_\alpha$, which depends on the way in which the distribution of matter changes, and is divergence-free because of the Einstein equations. In this way the dynamical content of symmetry principles is emphasized, and it is shown that Einstein's equations essentially follow from covariance alone. (auth)

18927 THE WEAK AND STRONG PRINCIPLES OF EQUIVALENCE. R. H. Dicke (Princeton Univ., N. J.). Ann. Phys. (N. Y.), 31: 235-9(Jan. 1965).

Harvey has argued that within the framework of the Nordström theory a spinning top falls with the wrong gravitational acceleration, and concludes from this that the "weak equivalence principle" does not define an interesting or significant class of gravitational theories. It is shown that Harvey's spinning top is not physically

realizable, and it is proved that physically realizable bodies, if isolated and sufficiently small, fall with the same gravitational acceleration in the Nordström theory. (auth)

18928 ON THE SYMMETRIC S-STATE COMPONENT OF THE TRITON WAVE FUNCTION. Malcolm McMillan (Univ. of British Columbia, Vancouver). Can. J. Phys., 43: 463-75(Mar. 1965).

Approximate forms of the symmetric S-state component of the triton wave function, which are improvements on the well-known exponential and Irving functions, are found. The method does not involve variational parameters; the functions are obtained from reduced Schroedinger equations found using the methods of Feshbach and Rubinow and of Morpurgo. Some properties of these equations and their solutions are given. The reduced equations are solved numerically for various phenomenological nucleon-nucleon potentials without hard cores, and the functions are presented graphically. The eigenvalues of the reduced equations differ from the experimental triton energy, as is to be expected if only the symmetric S-state component is considered, and in an effort to simulate the effect of the other components, the depth of the nucleon-nucleon potential is increased until the computed eigenvalues equal the experimental triton energy. The corresponding eigenfunctions are given graphically. The Coulomb radius of ^{3}He was calculated with each of the functions, and the values found are generally reasonable. (auth)

18929 FIELD QUANTUM THEORY ASSOCIATED WITH THE DESCRIPTION OF A PARTICLE-FIELD SYSTEM BY A NON-LINEAR WAVE EQUATION. Gerard Petiau (Universite, Paris). Compt. Rend., 259: 4525-7(Dec. 21, 1964). (In French)

A quantum field theory is associated with a scalar particle-scalar field model described by a non-linear system of wave equations of the first order. The harmonic oscillator of the quantization of the free field is replaced by an inharmonic oscillator. (tr-auth)

18930 SCATTERING BY A CENTRAL POTENTIAL IN A STRONG MAGNETIC FIELD. R. Katilyus. Fiz. Tverd. Tela, 6: 2837-45(1964).

The scattering of a charged particle, in a strong magnetic field, by an electrostatic potential whose radius of action is much greater than the Larmor radius. Since perturbation theory cannot be used. Schroedinger's equation is solved in cylindrical coordinates with the magnetic field along the z-axis. The repulsive and attractive potentials are considered. Expressions are obtained for the deviation of the particle from its initial direction, including the case of total reflection. Formation of bound states in the attractive potential case is considered. The solutions are compared with the classical expressions. (OTS)

18931 TUNNELING FROM A MANY-PARTICLE POINT OF VIEW. R. E. Prange (Univ. of Maryland, College Park). Lectures Many-Body Probl., 2: 137-46(1964).

Metal-to-metal tunneling through an oxide layer is considered, using the model of independent quasiparticles and taking into account only the Pauli principle. Bardeen's calculation for the hamiltonian in the presence of the barrier is presented, and it is shown using a single model of a tunnel junction described by a simple-barrier potential, that the Bardeen result is good for calculating the wave function only to first order. (M.J.T.)

18932 LIOUVILLE REPRESENTATION OF QUANTUM MECHANICS WITH APPLICATION TO RELAXATION PROCESSES. U. Fano (National Bureau of Standards, Washington, D. C.). Lectures Many-Body Probl., 2: 217-39(1964).

A self-contained presentation of the vector space formalism called the Liouville representation of quantum mechanics is given. The density matrix, the density matrix as a real state vector, symmetries and projections of the state vector, the equation of motion for density matrices, Fourier transformation, and relations between ordinary Hilbert space representation and the Liouville representation are discussed. The Liouville formalism is applied to the interactions of a system of interest, having a small number of degrees of freedom, with a noisy thermal reservoir; the transition operator, the initial state of the complete system, and the elimination of reservoir variables and diagonalization of the resolvent are described, and the Rayleigh-Schroedinger and low-density approximations and the short-memory expansion are considered. (M.J.T.)

18933 THE MATHEMATICS OF SECOND QUANTIZATION FOR SYSTEMS OF FERMIONS. E. R. Pike (Royal Radar Establishment, Malvern, Worcester, Eng.). Lectures Many-Body Probl., 2: 241-6(1964).

The proof for the equivalence of configuration space and second-quantization formalisms is discussed. Valentin's improvement of the treatment by Jordan and Wigner is reviewed, in which the exact mathematical nature of the equivalence, where annihilation and creation operations and the second-quantized description of states arise naturally as operations and elements of Grassman algebra, is stressed. The equivalence is then established, avoiding Valentin's detailed comparison of the complete sets of matrix elements of n-particle operators in configuration space and second-quantization formalisms. (M.J.T.)

18934 ON ASYMPTOTIC BEHAVIOR OF VERTEX PART IN SCALAR ELECTRODYNAMICS. K. Ahmed (Imperial Coll. of Science and Tech., London). Nucl. Phys., 66: 688-94(May 1965).

The vertex part in scalar electrodynamics with massive vector boson propagator is calculated. To satisfy Ward's identity contributions from two double corner diagrams are added. Asymptotic behavior when one and two variables go to infinity is deduced and compared with the remarks of Salam and Delbourgo. (auth)

18935 THE SHORT-WAVELENGTH APPROXIMATION TO THE SCHROEDINGER EQUATION. L. Bertocchi (Universita, Bologna), S. Fubini, and G. Furlan. Nuovo Cimento (10), 35: 599-631(Jan. 16, 1965).

The short-wavelength approximation to the Schrödinger equation in the presence of one and two turning points is examined. Two methods are presented which allow the evaluation of the higher corrections to the elementary W.K.B. approximation. The first method, the real method, employs higher transcendental functions, the second one uses complex integration techniques. (auth)

18936 ON THE POSSIBILITY OF A NEUTRINO THEORY OF LIGHT. B. Ferretti and I. Venturi (Universita, Bologna). Nuovo Cimento (10), 35: 644-50(Jan. 16, 1965).

An example is given of a neutrino model exhibiting the correct properties of polarization and statistics of photons. (auth)

18937 THE CLASSICAL MOTION OF SPIN-1 PARTICLES. J Sniatycki (Warsaw State Univ.). Nuovo Cimento (10), 35: 664-5(Jan. 16, 1965).

The classical equations of motion for spin-$\frac{1}{2}$ particles in a homogeneous electromagnetic field are extended to the case of spin-1 particles. (C.E.S.)

18938 ON SCALAR FIELDS AND POINT SOURCES. L. M. Scarfone (Univ. of Vermont, Burlington). Nuovo Cimento (10), 35: 694-6(Jan. 16, 1965).

The case in which two neutral scalar fields distinguished by their different masses m_1 and m_2 are coupled to each other by a direct product interaction of positive strength λ with one of the fields interacting with a single point source. The simplicity of the model enables one to express the original hamiltonian as the sum of two independent neutral scalar theories with coupling constants g and masses that are functions of m_1, m_2, g, and λ. Unlike the single-field situation where the mass of the meson is not an interaction parameter (so that a variation of it does not create a new orthogonal vector space), it is found that variations of m_1 and/or m_2 generate orthogonal spaces. It is clear that variations in λ and g also produce this effect. (C.E.S.)

18939 COMMUTATION RELATIONS FOR ENERGY-MOMENTUM TENSOR. I. Bialynicki-Birula (Warsaw State Univ.). Nuovo Cimento (10), 35: 697(Jan. 16, 1965).

The commutation relations for the T_{00} and T_{0k} components of the energy-momentum tensor in free electrodynamics expressed in terms of the T_{kl} components of this tensor are given. (C.E.S.)

18940 CPT IN FIVE-DIMENSIONAL SPACE. J. Rosen (Tel-Aviv Univ., Israel). Nuovo Cimento (10), 35: 698-9 (Jan. 16, 1965).

Interpretation of the inhomogeneous Lorentz group as a limiting case of the pseudo-rotation group in 5-dimensional pseudo-Euclidean space of metric $(+ - - - \pm)$ is considered. Rotations into the fifth dimension become space-time translations in the limit of the fifth metric component's vanishing. The effect of inversions in this 5-space is examined. (C.E.S.)

18941 ON THE UNIQUENESS OF PARITY AND TIME-REFLECTION OPERATORS. H. J. Braathen (Universitet, Oslo). Nuovo Cimento (10), 35: 703-5(Jan. 16, 1965).

The nomenclature, symbols, and definitions of a paper by Foldy (Phys. Rev., 102, 568 (1956)) investigating the representation of the full Lorentz group are used to examine the uniqueness of parity and time-reflection operators. (C.E.S.)

18942 INTERACTION OF ISOTOPIC GAUGE FIELDS WITH PHOTONS. K. H. Tzou (Universite de Paris, Orsay, France). Nuovo Cimento (10), 36: 604-27(Mar. 16, 1965).

The quantization of the following systems of interacting fields is studied: i) Yang-Mills isotopic gauge field interacting with the electromagnetic field; ii) partially isotopic gauge-invariant field (with nonvanishing mass terms and arbitrary anomalous moment type couplings); and iii) its interaction with the electromagnetic field (with arbitrary anomalous magnetic moment couplings). By assuming the isotopic charge to be small, the perturbative S-matrix theory is formulated for each of the three problems. The field system i) is renormalizable, but ii) and iii) are not. The interaction with the electromagnetic field by consistent couplings does not completely destroy the isotopic gauge invariance of the Yang-Mills field, but rather leads to an extended invariance of the whole system of two interacting fields with respect to a 4-dimensional gauge group called the combined charge-isotopic gauge group, which can still be generalized to include any number of kinds of photons. This extended gauge invariance enables us to take Lorentz gauge for both the electromagnetic and the isotopic gauge-invariant field and also permits a global covariant formalism for dealing with the subsidiary conditions of all the component zero-mass vector fields. In both problems ii) and iii), all anomalous moment interactions give rise to noncovariant high-order S-matrix elements and to extra-high-order divergences, but these difficulties all disappear in a certain particular case; the results of the two problems may be applied to analyzing the interaction among charged and neutral vector mesons of isospin one considered as isotopic gauge bosons and also their interaction with photons. (auth)

18943 INFORMATION THEORY IN QUANTUM STATISTICAL MECHANICS. P. A. Benioff (Argonne National Lab., Ill.). Phys. Letters, 14: 196-7(Feb. 1, 1965).

It is pointed out that the set of observables is not arbitrary in that at least one observable must have the property that its diagonal matrix elements in the eigenfunction representation of the maximum energy density operator must be monotonic increasing. (L.B.S.)

18944 THE GENERALIZATION OF THE WIGNER-RACAH ANGULAR MOMENTUM CALCULUS. PART II. L. C. Biedenharn (CERN, Geneva). Phys. Letters, 14: 254-5(Feb. 1, 1965).

It is shown that the generalization of the Wigner-Racah angular momentum calculus from the two-dimensional unimodular unitary group to the general semisimple compact Lie group is a canonical resolution of the multiplicity problem, explicitly for all SU_n and implicitly for other groups by imbedding in SU_n. (L.B.S.)

18945 A NOTE ON A PARTIAL SUMMATION OF GRAPHS IN MANY BODY THEORY. K. Kurki-Suonio (Univ. of Helsinki). Phys. Letters, 14: 298-9(Feb. 15, 1965).

A method is presented for performing a partial summation of graphs in many-body theory, which leads to the replacement of all kinetic energies with the Hartree-Fock energies and the convergence of the exponential series. (L.B.S.)

18946 DIFFICULTIES ARISING IN THE COMBINATION OF INTERNAL SYMMETRIES AND SPACE-TIME. H. J. Lipkin (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Letters, 14: 336-8(Feb. 15, 1965).

Examples of certain transformations which can change a state of a multiparticle system which is physically reasonable into a state which is physically inadmissible are discussed. The difficulty in attempting to generalize the concept of a spin-independent interaction to one which is invariant under spatial rotations as well as spin rotations is also discussed. (L.B.S.)

18947 PROOF OF THE IMPOSSIBILITY OF A DYNAMICAL DESCRIPTION OF WAVE PACKET "REDUCTION." Yu. M. Lomsadze, A. E. Kovalchuk, I. Yu. Krivskii (Uzhgorod State Univ., Ukrainian SSR). Phys. Letters, 15: 45-6(Mar. 1, 1965).

The Von Neumann theorem on the impossibility of the dynamical quantum-theory description of wave packet reduction is proved, correcting previous errors and without using an assumption which implies the indispensable repeatability of the result of measuring a physical quantity. Since the proof is based completely on the use of the unitarity and linearity of the S operator, it is concluded that a dynamical description of the measurement process is in principle impossible in the framework not only of current quantum mechanics and field theory, but also of any of their conceivable generalizations. (M.J.T.)

18948 THE LOGARITHMIC TERM IN THE GROUND-STATE ENERGY FORMULA OF A DILUTE FERMI-GAS OF HARD SPHERES. V. N. Efimov (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Letters, 15: 49-50(Mar. 1, 1965).

The logarithmic term, of the form $\gamma^4 \ln\gamma$, in the ground-state energy formula of a dilute Fermi gas of hard spheres is calculated, using Green functions and graphs of the particle amplitudes. It is shown that the calculation of the term proportional to γ^4 is impossible without a solution of a three-particle scattering problem. (M.J.T.)

18949 ON A METHOD TO CORRECT FOR PARTICLE NUMBER FLUCTUATIONS. J. Bang (Universitet, Copenhagen), J. Krumlinde, and S. G. Nilsson. Phys. Letters, 15: 55-7(Mar. 1, 1965).

The use of the BCS wave function in the nuclear case leads to an ensemble average for the energy that is of the order of magnitude Δ_0 larger than the energy for the particular component of the wave function that corresponds to the correct number of particles. The particle number fluctuation effect is significant in the blocking picture when states of different mean square deviation in particle number are compared. A simple method is presented to correct for the particle number fluctuation effect, using a projection method suggested by Michailov. Results are worked out both for the blocking model and for the continuous or uniform model. The method is tested by comparing results with those of exact calculations and calculations using a variational method. (M.J.T.)

18950 TOTAL ENERGY LOSS AND ČERENKOV EMISSION FROM MONOPOLES. Donald R. Tompkins (Louisiana State Univ., Baton Rouge). Phys. Rev., 138: B248-50(Apr. 12, 1965).

The Cherenkov emission and Fermi-theory energy loss of monopoles passing through a permeable medium are calculated. Based on their Cherenkov emission, a method of identifying fast monopoles is proposed. This method would complement the methods which only permit the identification of slowed-down monopoles. (auth)

18951 ENERGY OF INFINITELY LONG, CYLINDRICALLY SYMMETRIC SYSTEMS IN GENERAL RELATIVITY Kip S. Thorne (Princeton Univ., N. J.). Phys. Rev., 138: B251-66(Apr. 12, 1965).

A definition of energy is proposed for systems invariant

under rotations about, and translations along, a symmetry axis. This energy (which is called cylindrical energy or C energy) takes the form of a covariant vector P^i, which obeys the conservation law $P^i{}_{;i} = 0$. C energy is localizable and locally measurable: The component of P^i along the world line of an observer is the C-energy density he measures. Near the symmetry axis of a static system, where strong gravitational fields are absent, C-energy density reduces to proper mass density T^0_0. C energy is propagated by Einstein-Rosen gravitational waves and by cylindrical electromagnetic waves. In vacuo and in the presence of electromagnetic fields the C energy on a space-like hypersurface is minimized when the system is static; and the difference between the potential part and the kinetic part is a lagrangian for the Einstein-Maxwell field equations. The C energy can be a powerful tool in the analysis of finite as well as infinite cylindrically symmetric systems. It is used to elucidate the nature of Einstein-Rosen gravitational radiation, and to suggest and support the conjecture of flux resistance to gravitational collapse: In any configuration of electromagnetic fields collapsing toward a singularity, each electric and magnetic-field line is either entirely ejected from the collapsing region or entirely swallowed by it as collapse proceeds; there can be no flux threading a collapsed region. (auth)

18952 RELATION BETWEEN QUANTUM AND SEMICLASSICAL DESCRIPTION OF OPTICAL COHERENCE. C. L. Mehta (Univ. of Rochester, N. Y.) and E. C. G. Sudarshan. Phys. Rev., 138: B274-80(Apr. 12, 1965).

The problem of relating the semiclassical and quantum treatments of statistical states of an optical field is reexamined. The case where the rule of association between functions and operators is that of antinormal ordering is studied in detail. It is shown that the distribution function for each mode corresponding to this case is a continuous bounded function, and is also a boundary value of an entire analytic function of two variables. The nature of the distribution for the normal ordering rule of association and its relation to this entire function are discussed. It is shown that this distribution can be regarded as the limit of a sequence of tempered distributions in the following sense: One can find a sequence of density operators $\hat{\rho}_{(\nu)}$ which converges in the norm to the density operator $\hat{\rho}$ of any given field (consisting of a single mode), such that each member of the sequence can be expressed in the form $\hat{\rho}_{(\nu)} = \int \phi_{(\nu)}(z) |z\rangle\langle z| d^2z$, where $\phi_{(\nu)}$ is a tempered distribution. (auth)

18953 POST-NEWTONIAN EQUATIONS OF HYDRODYNAMICS AND THE STABILITY OF GASEOUS MASSES IN GENERAL RELATIVITY. S. Chandrasekhar (Univ. of Chicago). Phys. Rev. Letters, 14: 241-4(Feb. 22, 1965).

A derivation of the equations of hydrodynamics is presented, which allows for effects of order c^{-2} originating in the exact field equations of Einstein. The stability of gaseous masses with respect to nonradial oscillations is considered. (D.C.W.)

18954 ON THE EINSTEIN-PODOLSKY-ROSEN PARADOX. J. S. Bell (Univ. of Wisconsin, Madison). Physics, 1: 195-290(Nov.-Dec. 1964).

It is shown that the addition of parameters to quantum mechanics to determine the results of individual measurements is incompatible with the statistical predictions of quantum mechanics. (D.C.W.)

18955 FEYNMAN'S KERNEL AND THE CLASSICAL PATH. M. Clutton-Brock (Northampton Coll. of Advanced Tech., London). Proc. Cambridge Phil. Soc., 61: 201-5 (Jan. 1965).

The quantum mechanical kernel $K(q'',t''; q',t')$ in Feynman's form of a sum over paths is evaluated by means of the canonical transformation to the system Q,P for which the Hamiltonian vanishes identically. The kernel is found to be completely determined by the classical paths, and is given by $K(q'', t''; q',t') = A\Sigma_c[\partial(Q,P)/\partial(q',q'')] \exp[(i/\hbar)S(q'', P,t''; q',P,t')]$. The sum is over all classical paths leading from q' at t' to q'' at t''. $S(q'',P,t''; q',P,t')$ is the classical action along the classical path characterized by the constant momentum P. (auth)

18956 HYPERVIRIAL THEOREMS AND PERTURBATION THEORY IN QUANTUM MECHANICS. P. D. Robinson (Univ. of Sussex, Eng.). Proc. Roy. Soc. (London), Ser. A, 283: 229-37(Jan. 6, 1965).

Previous ideas about the way in which hypervirial theorems might be used to improve approximate wave functions are discussed. To provide a firmer foundation for these ideas, a link is established between hypervirial theorems and perturbation theory. It is proved that if the first-order perturbation correction to the expectation value of an arbitrary operator vanishes, then the approximate wave function used satisfies a certain hypervirial theorem. Conversely, if an arbitrary hypervirial theorem is satisfied by the wave function, then it is proved that the expectation values of certain operators have vanishing first-order corrections. Some consequences of the theory as applied to variational wave functions with optimum energy are developed. The results are illustrated by the use of a simple approximate wave function for the ground state of the helium atom. (auth)

18957 STATIONARY GRAVITATIONAL FIELDS DUE TO SYMMETRICAL SYSTEMS OF BODIES. P. S. Florides, J. L. Synge, and T. Yukawa (Trinity Coll., Dublin and Dublin Institute for Advanced Studies). Proc. Roy. Soc. (London), Ser. A, 284: 32-9(Feb. 9, 1965).

By a method of successive approximations given previously, it is possible to find the gravitational field of a single body, at rest or with stationary internal motion. That method involved the proof of certain critical conditions by an argument dependent on a topological fact—the surface of a body can be continuously transformed into the infinite sphere without passing through matter. This proof fails when the system consists of more than one body. The proof of quite a different kind is presented, based on the symmetry of the system and extending the method of successive approximations to cover systems consisting of several bodies, subject to certain conditions of symmetry. (auth)

18958 A METHOD FOR OBTAINING APPROXIMATE WAVE FUNCTIONS. Zung-hau Deng (Shangton Univ., China). Wu Li Hsueh Pao, 20: 1235-43(Dec. 1964). (In Chinese)

An approximate wave function $\tilde{\Psi}_k^{(0)}$ is operated on by the operators $\lambda - H$ and $(H-\lambda)^{-1}$, where H is the Hamiltonian operator of the quantum system under consideration. It is shown that, if the resulting function ϕ_k is continuous, finite and square integrable in the whole domain of the variables of H, it is a better approximate wave function to the eigenstate Ψ_k of the system than $\tilde{\Psi}_k^{(0)}$ is. The expectation value of H, calculated with ϕ_k as the wave function approaches that calculated by the method of second-order perturbation with $\{\Psi_k^{(0)}\}$ as unperturbated states. Polarizabilities of hydrogen-like ions are calculated, and good results are obtained. (auth)

18959 MODIFICATION OF THE DELVES VARIATION PRINCIPLE. Klaus Mueller (Technische Hochschule, Brunswick). Z. Naturforsch., 20a: 13-16(Jan. 1965).

A variation principle, similar to the Delves principle, is given for the (real) wave function itself. The principle does not give a bound. The relation between both principles is discussed. After proper generalization a variation principle for arbitrary probability amplitudes (or generalized Fourier coefficients) is obtained. (auth)

18960 SU_n SYMMETRY IN THE THEORY OF CLEBSCH-GORDAN COEFFICIENTS. L. A. Shelepin (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 360-7 (Jan. 1965). (In Russian)

The transformation properties of Clebsch–Gordan coefficients relative to the SU_n group are used as a basis of a theory of the coefficients. It is shown that the Regge relations for Clebsch–Gordan coefficients are one of the manifestations of SU_n symmetry. A number of relations between Clebsch–Gordan coefficients and their combinations are determined. Some new types of combinations are introduced. Relevance of the results to field theory is discussed. (auth)

18961 INTRODUCTION TO ADVANCED FIELD THEORY. G. Barton. Interscience Tracts on Physics and Astronomy. Volume 22. New York, Interscience Publishers, 1963. 172p.

A presentation of field theory of elementary particles is given, assuming previous acquaintance with covariant perturbation theory and with Feynman diagrams. Discussions are presented on the interpolating field and asymptotic condition, free field quantization, the contraction scheme, Green's functions, the inhomogeneous wave equation, construction of the interpolating field from the S operator, Lagrangians for coupled fields, the Lehmann representation of the two-point functions, the LSZ theorem on the vertex function, ghosts in perturbation theory, the Lee model and negative probabilities, an infinite number of degrees of freedom, and Haag's theorem. (M.J.T.)

18962 CONCEPTS IN QUANTUM MECHANICS. F. A. Kaempffer. Pure and Applied Physics. Volume 18. A Series of Monographs and Textbooks. New York, Academic Press, 1965. 371p. $9.75.

An attempt is made to break away from traditional presentations of quantum mechanics, by avoiding reliance on arguments based on comparison with classical physics and by emphasizing topics of contemporary interest. Emphasis is given to the description of symmetry properties without the use of group theory and to the elementary treatment of topics such as time reversal invariance, super-selection rules, and the interaction picture. (M.J.T.)

18963 QUANTUM PHYSICS OF ELECTRONICS. Sumner N. Levine. New York, The Macmillan Company, 1965. 311p.

Physical principles needed to understand electronic devices are presented. An introduction to quantum mechanics is given. This quantum mechanical background is then used to develop topics such as statistical thermodynamics, electron emission, band theory of solids, transport theory, and electromagnetic interactions, with a brief introduction to masers and lasers. (M.J.T.)

18964 QUANTUM MECHANICS. D. I. Blokhintsev. Translated from Osnovy Kvantovoi Mekhaniki. Dordrecht, Holland, D. Reidel Publishing Company, 1964. 548p.

An understanding of the physical basis and mathematical formalism of quantum mechanics is provided for the beginning student, and ways in which quantum mechanics can be applied in various branches of atomic physics are indicated by examples. Discussions are given of the foundations of quantum mechanics, the use of operators, variations with time, the theory of representations, perturbation theory, collision theory, the many-body problem, and second quantization and quantum statistics. Applications are made to optics, particle motion in a potential field, quantum transitions, scattering of light by atoms, multi-electron atoms, molecule formation, magnetic phenomena, and the atomic nucleus. 106 references. (M.J.T.)

18965 THE SPECIAL THEORY OF RELATIVITY. David Bohm. Lecture Notes and Supplements in Physics. New York, W. A. Benjamin, Inc., 1965. 249p.

Relativity theory is presented as a unified whole, explaining its basic meaning in nonmathematical terms where possible. Prerelativistic physics and the Lorentz ether theory are reviewed, bringing out the assumptions behind common-sense and Newtonian notions of space and time. Einstein's analysis of the concept of simultaneity, implications of the Lorentz transformation, the Minkowski diagram, K-calculus, and four-dimensional space-time geometry are discussed. (M.J.T.)

Geophysics

Refer also to abstracts 18138 and 18676.

18966 (NP-14436(Rev.)) THE TAIL OF THE MAGNETOSPHERE. Research Report No. 190. W. I. Axford, H. E. Petschek, and G. L. Siscoe (Avco-Everett Research Lab., Everett, Mass.). Aug. 1964. Revised Dec. 1964. Contract NAS-w-837. 14p.

The Chapman and Ferraro model of the magnetosphere is entirely dissipationless, and as a consequence contains no tangential stress at the magnetosphere boundary. It has been suggested that either viscous interaction or reconnection of field lines can give rise to tangential stresses, which produce internal convection within the magnetosphere. A number of auroral and ionospheric observations appear to be consistent with such a convection pattern. It was also suggested that tangential stresses might stretch the magnetosphere tail and thus account for the main phase of magnetic storms. It is noted that measurements related to the magnetosphere tail lend support to the suggestion that tangential stresses play a significant role. In particular the observations of a strong magnetic field in the tail aligned radially from the earth, the departures of the magnetic field from the Finch and Leaton field in the neighborhood of 5 to 12 earth radii in the anti-solar direction, the existence of particle fluxes in the tail, the latitude of the boundary of trapped particles as well as its day-night asymmetry, and the low-energy cosmic-ray cutoff are all consistent with this picture. Furthermore it appears that the tail provides a specific mechanism for injection of energy into the body of the magnetosphere. (auth)

18967 (NP-14826) THERMAL DESIGN AND PERFORMANCE OF AN EARTH SATELLITE LAUNCHED SHORTLY AFTER A HIGH-ALTITUDE NUCLEAR EXPLOSION. Kenneth F. Read (Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab.). Aug. 1964. Contract NOw-62-0604-c. 97p. (CM-1046)

This report presents the development of a new thermal analysis technique that offers the singular advantage of providing a rapid first approximation to the thermal design of near-earth satellites. In particular, the application of this method of analysis is demonstrated by showing how this technique was used in the thermal design of a satellite that was launched shortly after the first high-altitude nuclear explosion. (auth)

18968 (RM-4388) TRANSMISSION OF MICROPULSATIONS THROUGH THE LOWER IONOSPHERE. Carl Greifinger and Phyllis Greifinger (RAND Corp., Santa Monica, Calif.). Feb. 1965. 46p.

The propagation through the ionosphere of sub-extremely low-frequency (<0.1 cps) hydromagnetic waves is studied. The case of plane wave propagation in the vertical direction in the presence of a uniform magnetic field (which is also in the vertical direction) (so-called polar propagation) is considered. The purpose is to separate out the effects of the ionosphere on hydromagnetic disturbances propagating through it. The ionosphere is assumed to extend infinitely far in the upward direction and to terminate abruptly 80 km above a perfectly conducting flat earth. The charged particle density is assumed to be constant throughout the ionosphere, and the neutral particle density to vary exponentially with altitude. The coupled hydrodynamic and electromagnetic equations for the medium are linearized, and, with the approximations valid for low-frequency waves, the resulting system is shown to reduce to a second-order wave equation. A steady-state solution of this equation is obtained, from which transmission and reflection coefficients are calculated. It is found that, for ionospheric conditions corresponding to daytime at sunspot maximum, the transmission coefficient exhibits a pronounced resonance at a frequency of about 0.015 cps. Since this is approximately the frequency of so-called Pc oscillations, it is suggested that the resonance just described accounts for these natural micropulsations in the geomagnetic field. It is found that the resonance shifts to higher frequencies at night, also in agreement with the data on natural Pc oscillations. It is shown that the presence of an almost perfectly conducting ground (at these frequencies) is important in determining the location of the resonance. Finally, it is shown that disturbances reaching the ground, in the polar regions, should be very nearly left-circularly polarized. (auth)

18969 (TID-21471) ENERGY GENERATION THROUGH RADIATIVE PROCESSES IN THE LOWER STRATOSPHERE. Report No. 11. James S. Kennedy (Massachusetts Inst. of

Tech., Cambridge. Dept. of Meteorology). Dec. 1, 1964. Contract AT(30-1)-2241. 123p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

The generation of zonal available potential energy by radiative processes and its seasonal variation was examined in the region of the lower stratosphere. To determine the magnitude of the generation, the heating and cooling rates were computed in the lower stratosphere due to solar absorption and infrared radiative transfer due to carbon dioxide, water vapor, and ozone. It was found that the 15-20 km layer in winter and spring and the 13-20 km layer in summer are regions where radiative processes produce large rates of destruction of zonal available potential energy. The size of the destruction rate indicates that the lower stratosphere depends on the troposphere as a source of kinetic energy. It was further determined that radiative processes produce excess heating at low latitudes and a deficit of heat at high latitudes in the lower stratosphere. The relative magnitudes of heating and cooling indicate that the lower stratosphere is thermally deficient as a whole and must rely on other levels of the atmosphere for thermal as well as kinetic energy. (auth)

18970 (FTD-TT-64-1316) COSMIC RESEARCH. Translation of Kosmicheskie Issledovaniya, 2: No, 6, 817-956(1964). 232p.

For abstracts of individual papers see: 17494, 18723, 18724, 18971, and 19266.

18971 (FTD-TT-64-1316(p.75-101)) THE FORMATION OF IONS IN THE IONOSPHERE. A. D. Danilov. Translated from Kosmich. Issled., 2: 865-80(1964).

Questions relating to the formation of primary ions in the ionosphere at altitudes of 100–200 km are considered. A comparison of the effectiveness of the various processes provides the basis for the selection of the primary means of forming each ion. The calculation of the equilibrium concentrations of the ions O^+, NO^+, O_2^+, and N_2^+ is presented for the various zenith angles of the sun. It is demonstrated that the altitude curves of the concentrations of these ions and of the concentration ratios, these curves having been computed theoretically, are in good agreement with existing experimental data for various magnitudes of z_0. The adoption of the Hinteregger data on the low intensity of ultraviolet radiation from the sun, or of the Ivanov-Kholodnyy data on a heavy flux in the ultraviolet region of the spectrum, does not significantly change the derived conclusion regarding the coincidence of ion-concentration distribution, calculated theoretically and measured experimentally, but leads rather to change in the magnitudes of the process constants. The derived data make it possible to evaluate the most probable values of the constants for the primary processes taking place in the ionosphere. (auth)

18972 VARIATION OF PROTON FLUX WITH ATMOSPHERIC DEPTH BETWEEN 10 AND 50 G/CM^2 AT λ = 47°S. GEOMAGNETIC. K. K. M. Wu and B. S. K. Chow (Univ. of Melbourne). Australian J. Phys., 18: 59-66(Feb. 1965).

Proton fluxes at atmospheric depths between 10 and 50 g/cm^2 were measured using nuclear emulsions during a series of balloon fights over Melbourne (λ = 47°S/geomagnetic) in the period November 1961–April 1962. The proton flux J(x) decreases with increasing depth within this region. It can be represented by the relation log J(x) = 3.05 ± 0.02 – 2.36 ± 0.66 × 10^{-3}x and, when extrapolated, gives the flux at the top of the atmosphere to be 1120 ± 50 protons m^{-2} steradian^{-1} s^{-1}. (auth)

18973 GEOMAGNETIC AND IONOSPHERIC OBSERVATIONS ASSOCIATED WITH AURORAL ACTIVITY DURING THE TOTAL SOLAR ECLIPSE OF JULY 20, 1963. T. A. Clark and C. D. Anger (Univ. of Alberta, Calgary). Can. J. Phys., 43: 457-62(Mar. 1965).

Data obtained at Fort Providence, N.W.T., Canada, during the total solar eclipse of July 20, 1963, indicate that during most of the partial eclipse there was a moderate degree of auroral activity. This activity became slight during the period of totality and no auroral luminosity was detected. Electron precipitation was indicated by an enhancement of the intensity of x rays of energy greater than 9 kev at balloon altitudes and by small amounts of cosmic-noise absorption. A small but irregular increase in cosmic-noise level at 30 Mc/s, which was greater than 0.2 db at totality, was recorded. It was concluded that the irregularity was caused by small amounts of superimposed auroral absorption. (auth)

18974 THERMAL HISTORY OF THE EARTH. I. THE FORMATION OF THE CORE. D. C. Tozer (Univ. of Newcastle upon Tyne, Eng.). Geophys. J., 9: 95-112(Feb. 1965).

As part of a discussion of thermal phenomena in the Earth when convection is taken into account, core formation is studied in order to ascertain whether the energy released in this process is significant at the present time. It is also a necessary preliminary to deciding whether mantle convection at the present time is thermal in origin. A method is developed for computing the energy released by core formation, subject to certain restrictions on the changes of entropy in the Earth. Several models for the kinetics of core formation are discussed, none of which is wholly satisfactory. By considering observational evidence that indicates non-hydrostatic stresses in the Earth, it is inferred that at the present time core formation is virtually complete and that the energy released by this process is hundreds of times less than the probable radioactive heat generation. From this it is concluded that as a first approximation the present convection in the large-scale Earth may be understood as the effect of thermally generated buoyancy forces. (auth)

18975 TEMPERATURE AND DENSITY IN THE IONIZED UPPER ATMOSPHERE AT 4000 TO 5300 KILOMETERS. David N. Anderson (North Carolina State Univ., Raleigh), Willard H. Bennett, and Leslie C. Hale. J. Geophys. Res., 70: 1031-8(Mar. 1, 1965). (LA-DC-6509(Rev.))

Measurements of the ion density between 550 and 5500 km made in 1960 were given in a preliminary report by Hale and were interpreted by Hanson. Hale's preliminary data indicated that the density began to increase with increasing altitude above 4200 km, but this fact was neither noted nor explained at that time. Laboratory calibrations and re-evaluation of the 1960 data initiated at North Carolina State in 1962 show that either the density increases more than fourfold between 4000 and 5500 km and is increasing rapidly at the upper value, or the temperature is greater than 32,000°K in this altitude range. Further measurements are needed to determine which interpretation is correct. (auth)

18976 ENERGETIC ELECTRON FLUXES IN AND BEYOND THE EARTH'S OUTER MAGNETOSPHERE. K. A. Anderson, H. K. Harris, and R. J. Paoli (Univ. of California, Berkeley). J. Geophys. Res., 70: 1039-50(Mar. 1, 1965).

The highly eccentric orbit of the Imp A satellite permitted an extension of energetic charged particle measurements to distances of 31.5 earth radii. Fluxes of energetic electrons on the order of 10^4 sec^{-1} were frequently measured in the transition region and in interplanetary space. The occurrence of electrons in regions where there can be no geomagnetic trapping was found to be more frequent on the sides of the geomagnetic cavity than over the subsolar region. Arguments that the origin of the electrons found outside regions of geomagnetic trapping is magnetospheric are given. In the tail of the geomagnetic cavity, there are islands of energetic electron fluxes up to 10^4 cm^{-2} sec^{-1} and several earth radii in spatial extent. These electron islands seem to be confined to a rather small region of latitudes. (auth)

18977 ON THE STABILITY OF THE CLOSED MAGNETOSPHERE. B. U. O. Sonnerup (Royal Inst. of Tech., Stockholm). J. Geophys. Res., 70: 1051-60(Mar. 1, 1965).

The stability of the closed magnetosphere is studied for the case in which the interplanetary field opposes the terrestrial field in the equatorial plane. In the limit of a vanishing solar wind, the closed equilibrium configuration,

consisting of a spherical geomagnetic cavity surrounded by a field-reversing current layer, is shown to be unstable. It transforms spontaneously into an open configuration of Dungey's type, where the earth's polar field lines reach into interplanetary space. The influence of an external plasma flow such as the solar wind is discussed qualitatively. Such a flow may normally prevent the occurrence of the instability so that the closed configuration is preserved. However, in special circumstances the instability can probably develop also in the presence of the solar wind. It is tentatively suggested that the transition from the initial to the main phase of some magnetic storms is related to a transformation from the closed to the open magnetosphere. (auth)

18978 EXPECTED SPATIAL DISTRIBUTION OF LOW-ENERGY PROTONS PRECIPITATED IN THE AURORAL ZONES. Gerald T. Davidson (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Geophys. Res., 70: 1061-8 (Mar. 1, 1965).

A Monte Carlo method was used to compute the latitudinal dispersion in the auroral zone of 5- to 20-kev protons injected on a magnetic field line with equatorial pitch angles less than 3°. Neutral hydrogen atoms resulting from charge exchange at altitudes of 300 to 500 km were found to travel large distances across field lines. An isotropic injection pitch angle distribution results in precipitation of protons and hydrogen atoms in the atmosphere over an area as wide as 600 km. The associated auroral Balmer α emission is also expected to originate in a region several hundred kilometers wide. The mechanism described here seems adequate to account for the diffuseness of observed auroral hydrogen emission. (auth)

18979 HYDROMAGNETIC WHISTLERS. Tatsuzo Obayashi (Goddard Inst. for Space Studies, New York). J. Geophys. Res., 70: 1069-78(Mar. 1, 1965).

Hydromagnetic emissions consisting of a series of overlapping wavetrains of rising frequency are explained by hydromagnetic waves of anisotropic mode propagating along the field-aligned paths in the magnetosphere. The rising frequency of emission is attributed to the dispersive nature of the velocity of waves; the repetitive period of wavetrains is associated with the transit time of the wave packet bouncing between geomagnetic conjugate points along the line of force. It is suggested that an initiating wave is triggered by spontaneously injected high energy particles of superluminal motion and that the wave is subsequently amplified by plasma beams through the mechanism of cyclotron instabilities. (auth)

18980 AURORAL ZONE EMISSIONS CENTERED AT 700 CYCLES PER SECOND. Alv Egeland (Kiruna Geophysical Observatory, Sweden), Georg Gustaffson, Sven Olsen, Jules Aarons, and William Barron. J. Geophys. Res., 70: 1079-82(Mar. 1, 1965).

An emission band between 500 and 1000 cps was frequently recorded at the Kiruna Geophysical Observatory (geomagnetic latitude 65.3°N) by a swept frequency battery-operated analyzer. The most important characteristics of this enhanced electromagnetic radiation are the following: the maximum signal strength is observed at a fixed frequency 700 ± 100 cps; the bandwidth of the emission is normally less than 500 cps; and the shape of the emission band is asymmetrical. The hypothesis advanced is that this emission band may be due to radiation at the gyrofrequency of protons. Propagation conditions determine the latitude where this band emission can be detected on the ground. (auth)

18981 CALCULATIONS OF ULTRAVIOLET MOLECULAR NITROGEN EMISSIONS FROM THE AURORA. A. E. S. Green (Univ. of Florida, Gainesville) and C. A. Barth. J. Geophys. Res., 70: 1083-92(Mar. 1, 1965).

The experimental data on inelastic collisions in atmospheric gases are used in conjunction with a phenomenological generalization of the Born approximation to arrive at a model set of excitation and ionization cross sections for N_2. Then Bethe's theory of stopping power is extended to arrive at a fractional energy loss function for low-energy electrons in molecular nitrogen. These functions are used to calculate the energy deposited in various discrete and continuous states of nitrogen resulting from the slow down of electrons. Particular attention is given to the energies in the kev region, which are probably of considerable importance in auroral phenomena. The results of a sample calculation indicate that a large fraction of the energy ultimately ends up in ultraviolet emitting states. The implications of these results with respect to the ultraviolet aurora are discussed. (auth)

18982 A STUDY OF AURORAL ABSORPTION EVENTS AT THE SOUTH POLE. 2. CONJUGATE PROPERTIES. J. K. Hargreaves and H. J. A. Chivers (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 70: 1093-1102(Mar. 1, 1965).

At South Pole and Frobisher Bay, a magnetically conjugate pair of high-latitude stations, the auroral absorption events observed with riometers have many points of similarity. Yet there are also some significant differences, which have been brought out in this study by a detailed, event-for-event comparison. First, systematic changes were detected in the relative intensity of the events, such that the absorption tends to be relatively greater in local winter. There is also a diurnal change in the relative intensity. Second, there is good evidence that the event maximums appear in the conjugate regions at slightly different times; for individual events the time differences are correlated with the relative intensities. The results suggest that auroral absorption might be either produced or modulated by hydromagnetic disturbances propagating in the magnetosphere. (auth)

18983 PEARL-TYPE MICROPULSATIONS ASSOCIATED WITH MAGNETIC STORM SUDDEN COMMENCEMENTS. R. R. Heacock and V. P. Hessler (Univ. of Alaska, College). J. Geophys. Res., 70: 1103-11(Mar. 1, 1965).

Two years of continuous telluric current micropulsation records from College were scanned for evidence of a significant relation between magnetic storm sudden commencements (ssc) and pearl-type events that follow closely after the ssc's. Thirteen of 24 ssc's were followed by pearl events. Ten of these events occurred between 1200 and 2000 LMT, during which time there were 11 ssc's. Eight structured pearl events were found. The most prominent pearl events followed the ssc's that were preceded by very quiet magnetic field conditions. (auth)

18984 ON THE HARMONICS OF THE GYROFREQUENCY OBSERVED ON TOPSIDE IONOGRAMS. G. Wallis (Heinrich-Hertz-Institut, Berlin). J. Geophys. Res., 70: 1113-17(Mar. 1, 1965).

The plasma resonances appearing on topside ionograms at the plasma frequency, at the "hybrid frequency" ω_M, the harmonic $2\omega_M$, and at the gyrofrequency ω_H and the harmonics $p \cdot \omega_H$ are discussed on the basis of the kinetic theory (linearized Vlasov equation), including the thermal motion of the electrons. The results are compared with those of the dispersion relation for a cold plasma (magnetoionic theory). (auth)

18985 THEORY OF COLLECTIVE SPIKES OBSERVED BY THE ALOUETTE TOPSIDE SOUNDER. J. Nuttall (RCA Victor Research Labs., Montreal). J. Geophys. Res. 70: 1119-25(Mar. 1, 1965).

A theory is advanced to explain the spikes at the plasma frequency ω_p and the Pythagoras frequency $[(\omega_p^2 + \omega_B^2)^{1/2}]$ observed in ionograms of the Alouette topside sounder. It is based on the properties of Green's function for a uniform magnetoplasma, which may be cold or warm, and it disregards possible sheath effects. The theory predicts the absolute strength of the observed signal, its asymptotic time behavior, and its dependence on the orientation of the satellite antenna, but the present experimental data are insufficient to make detailed comparisons. (auth)

18986 LATITUDINAL AND SEASONAL VARIATIONS IN THE NIGHT AIRGLOW. T. N. Davis (Univ. of Alaska, College) and L. L. Smith. J. Geophys. Res., 70: 1127-38 (Mar. 1, 1965).

A four-color turret photometer was used for shipboard observations of the night airglow and the aurora. Zenith observations were made during 1962 close to the 70°W merid-

ian from the northern auroral zone to the antarctic pack ice. Most of the observations were taken during the southern winter. Maximums in the [O I] 5577 Å intensity were found near 30 to 40°N and 40°S, the southern hemisphere level being generally lower than that in the northern hemisphere. The [O I] 6300 Å latitudinal variation was similar to that of [O I] 5577 Å except that maximums in the latitudinal distribution were found near 15° geomagnetic north and south latitudes. In contrast with the [O I] emissions, the sodium group (Na D doublet and OH bands near 5893 Å) generally increased to the south with maximums near 20 to 30°N and 40 to 59°S geographic latitude. The total 5340 Å background increased from north to south. When the integrated starlight and zodiacal light components were substracted from the total background, the resultant terrestrial component showed a pronounced minimum at low latitudes and apparent symmetry about the geomagnetic equator. (auth)

18987 CAUSE OF THE MID-LATITUDE EVENING INCREASE IN f_0F_2. J. V. Evans (Massachusetts Inst. of Tech., Lexington). J. Geophys. Res., 70: 1175-85(Mar. 1, 1965).

The behavior of the electron density and temperature in the F_2 region above Millstone Hill radar observatory (42.6°N, 71.5°W) was explored throughout 1963 by means of radar backscatter experiments. Results are presented for April, July, and November 1963. It is shown that the evening increase in f_0F_2, observable at mid-latitude stations in summer, is caused by downward diffusion of ionization from above $h_{max}F_2$. This motion appears to be induced by the large fall in the electron temperature T_e that occurs at sunset. On the basis of this explanation, it is possible to show why the evening increase is absent in winter and is less pronounced at sunspot maximum, and also to account for the particularly pronounced effect for North American stations. (auth)

18988 GEOMAGNETIC ACTIVITY AND OCCURRENCE OF SPORADIC E IN THE FAR EAST. Yinn-nien Huang (Radio Wave Research Labs., Ching-Mei, Taipei Hsian, Taiwan, China). J. Geophys. Res., 70: 1187-94(Mar. 1, 1965).

The correlation between occurrence of sporadic E and magnetic activity was reported to be zero up to 30°N geomagnetic latitude by Smith and Thomas and Smith. Because there are large gaps between stations in this region, however, Smith has noted that the situation is not clear below about 20°N. Using the data obtained during ten summer months of IGY and IGC 1959 for the stations in the Far East, three of which are located below about 20°N, it is shown that a positive correlation exists from 5 to 30°N geomagnetic latitude, and that the correlation becomes negative around 30°N. The diurnal variation of geomagnetic effect on the occurrence of E_s is also investigated. (auth)

18989 A MATHEMATICAL TECHNIQUE FOR THE CONVERSION OF RADIO WAVE INTERACTION DATA TO D-REGION ELECTRON DENSITY PROFILES. F. V. Hellrich and A. J. Ferraro (Pennsylvania State Univ., University Park). J. Geophys. Res., 70: 1195-1205(Mar. 1, 1965).

A method for the conversion of amplitude and phase interaction data to electron density profiles is developed. The method, using an iterative least squares error technique, synthesizes electron density profiles having a piece-wise linear functional form. With model studies the method is evaluated with respect to the errors that may be produced in the synthesized profile arising from uncertain values of collision frequency, disturbing pulse power, energy loss coefficient, and coefficients of interaction. Also, a demonstration of the effectiveness of the combined use of amplitude and phase interaction in producing a more accurate profile than could be obtained with amplitude data alone is presented. The method was very successful in the synthesis of electron density profiles from actual interaction data and is presently being used for the reduction of data procured at the Ionosphere Research Laboratory during the International Quiet Sun Year. Some of these preliminary D-region profiles are presented. (auth)

18990 GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln, ed. (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 70: 1227-9(Mar. 1, 1965).

Data on geomagnetic activity, primarily for July–Oct. 1964, are presented, together with provisional sunspot numbers for Oct. 1964. Some solar-flare effects observed in early 1964 are also included. (D.C.W.)

18991 EVIDENCE SUGGESTING DUMPING OF SEMI-TRAPPED ELECTRONS ON THE NIGHT SIDE OF THE EARTH. J. R. Barcus (Univ. of California, Berkeley). J. Geophys. Res., 70: 1237-9(Mar. 1, 1965).

Using a scintillation detector flown on a balloon from Barrow, Alaska, on March 10, 1963, an x-ray event was observed, the intensity of which indicates dumping of semi-trapped electrons in the outer zone. (D.C.W.)

18992 PRELIMINARY RESULTS OF MEASUREMENTS OF THE EQUATORIAL ELECTROJET OVER INDIA. N. C. Maynard, L. J. Cahill, Jr., and T. S. G. Sastry (Univ. of New Hampshire, Durham). J. Geophys. Res., 70: 1241-5 (Mar. 1, 1965).

The electron density and magnetic field were measured using a rocket launched to the west from near the magnetic dip equator in India in Jan. 1964. The field measurements indicate a horizontal current sheet flowing from west to east at about 55 km down from apogee (170 km). No evidence for a thin layer of high electron density of the type associated with sporadic E at other latitudes was observed. (D.C.W.)

18993 OBSERVATIONS OF LONG-PERIOD PULSATIONS OF ELECTRON PRECIPITATION IN CONJUGATE REGIONS OF THE AURORAL ZONES. R. R. Brown (Univ. of California, Berkeley), J. R. Barcus, J. Reid, and N. R. Parsons. J. Geophys. Res., 70: 1246-9(Mar. 1, 1965).

Observations of a long-period pulsation event in ionospheric absorption of cosmic radio noise at Kotzebue, Alaska, and Macquarie Island, Antarctica, on Feb. 25, 1964, are summarized. Pulsations observed in the x-ray intensity at the same locations are also discussed. (D.C.W.)

18994 IONOSPHERIC ELECTRON CONTENT MEASUREMENTS DURING A SOLAR ECLIPSE. J. A. Klobuchar and H. E. Whitney (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 70: 1254-7(Mar. 1, 1965).

The variations in the total electron content of the ionosphere during the solar eclipse of July 20, 1963, were measured by observing the Faraday rotation of the polarization of linearly polarized radio waves reflected from the moon. (D.C.W.)

18995 THE USE OF ELECTROMAGNETIC SIGNALS EMITTED FROM NUCLEAR EXPLOSIONS TO STUDY LONG-RANGE VLF PROPAGATION. A. G. Jean and J. R. Wait (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 70: 1258-61(Mar. 1, 1965).

The analysis of observations on propagation of v-l-f radiation from nuclear explosions at long distances from the test site is outlined. Results for the attenuation rates obtained from signals received in the Western United States from the Redwing series of June 1956 are included, together with results for operation Castle at Bikini Atoll as observed at Eniwetok and Stanford. (D.C.W.)

18996 SPECTROGRAPHIC OBSERVATION OF A MID-LATITUDE RED AURORAL ARC. N. P. Carleton (Harvard Univ., Cambridge, Mass.) and J. R. Roach. J. Geophys. Res., 70: 1262-4(Mar. 1, 1965).

A clear enhancement of the oxygen lines of 6300 to 6364 Å well to the south of an auroral display observed at Fritz Peak, Colo. (magnetic invariant latitude 48°25′), was detected together with a possible faint enhancement of the 5200-Å nitrogen line. An interpretation in terms of excitation by thermal electrons was attempted. (D.C.W.)

18997 POLAR PROPAGATION DURING SHORT-WAVE FADEOUTS. H. L. Hadaller and D. H. Schrader (Washington State Univ., Pullman). J. Geophys. Res., 70: 1265-9 (Mar. 1, 1965).

Enhanced signal reception (18 Mc/sec) during reported short-wave fadeouts was observed on a propagation path from Thule, Greenland, to Pullman, Washington. The enhancements may have been due to increases in E- or F-layer electron densities. (D.C.W.)

18998 ON THE STRUCTURE OF THE COLLISION-FREE BOW SHOCK WAVE. J. G. Cordey (London Univ.). J. Geophys. Res., 70: 1278-80(Mar. 1, 1965).

A model of the collisionless bow shock wave due to the interaction of the solar wind with the geomagnetic field is presented. It is found that waves are generated in the shock front, and it is proposed that these waves may account for some of the irregularities of the disordered region. (D.C.W.)

18999 DEPENDENCE OF THE CRITICAL FREQUENCY OF THE IONOSPHERIC E-LAYER ON SOLAR ZENITH ANGLE AND THE ANNUAL VARIATION IN E-LAYER IONIZATION. Tatsuo Shimazaki (National Bureau of Standards, Boulder, Colo.). Nature, 205: 889-91(Feb. 27, 1965).

The annual, diurnal, and latitude variations of f_0E as a function of the solar zenith angle are discussed. The annual variation of E-layer ionization is considered in connection with the seasonal difference in f_0E at the sub-solar point. (D.C.W.)

19000 EQUATORIAL SPORADIC E IONIZATION AND ELECTROJET EFFECT OF GEOMAGNETIC DISTURBANCES. K. M. Kotadia (Gujarat Univ., Ahmedabad, India). Proc. Indian Acad. Sci., Sect. A, 60: 352-67(Nov. 1964).

The ionospheric data of Kodaikanal (magnetic dip 3.5° N) were examined to study the relation between the critical frequency of the equatorial sporadic E layer and the horizontal component (H) of the earth's magnetic field, with special reference to the behaviour of the electrojet both under normal and under disturbed conditions. Some specific SC type magnetic storms were analyzed to study the effect of the storms on the electrojet. It is shown that the blanketing frequency of Es can be taken to be equal to the critical frequency (foEs) of the normal E-layer, and it is suggested that the high value of foEs might be due to the subsidence and conversion of E layer ionization into eddy-clouds forming as a result of strong wind shear in the electrojet. It is also shown that foEs and H are fairly well connected under normal conditions, but the connection is not simple under disturbed conditions. Further, the effect of a magnetic storm in reducing the electrojet current during the main phase is greater in the morning and evening hours; it appears that a depression of about 100 gammas in H-field is necessary before any significant reduction in the electrojet occurs at midday. Finally, some abnormalities in the variations of foEs and H are pointed out. (auth)

19001 EFFECT OF FALLOUT ON ELEMENTS OF ATMOSPHERIC ELECTRICITY. Jozef Gadomski. Przeglad Geofiz., 9: 227-42(1964). (In Polish)

The possible effect on elements of atmospheric electricity of increased ionization due to radiation by artificial radioactive fallout was studied. The material used for this purpose included data on electric field intensity, air conductivity, number of condensation nuclei, air and ground temperatures, atmospheric precipitation, and data on fallout on the grounds of the Institute of Nuclear Research Warsaw–Żerań and Świerk. Analysis of the data indicates a distinct influence of fallout on air conductivity in the period investigated. Higher conductivity values were observed concurrently with deposition of major amounts of fallout from March to August 1959, from September to November 1961, and from May to November 1962, while in the fall 1959 conductivity was influenced by extra ionization caused by the artificial radioactive fallout accumulated on the ground. The changes in electric field intensity occurring in the above periods are less distinct. It was also observed that the effect of fallout may be considerably diminished by atmospheric precipitation, which agrees with Pierce's findings. (auth)

19002 SYMPOSIUM ON ULTRA LOW FREQUENCY ELECTROMAGNETIC FIELDS, JUNE 18, 1964. Rept. Ionosphere Space Res. Japan, 18: 161-239(1964). (CONF-640616)

Separate abstracts were prepared for seven of the ten papers included. The remaining papers deal with geomagnetic pulsations. (D.C.W.)

For abstracts of individual papers see: 19003, 19004, 19005, 19006, 19007, 19008, and 19009.

19003 AURORAL RADAR ECHOES ASSOCIATED WITH pc-5. Eisuke Kaneda, Susumu Kokubun, Takasi Oguti, and Takesi Nagata (Tokyo Univ.). Rept. Ionosphere Space Res. Japan, 18: 165-72(1964).

The characteristics of auroral radar echoes associated with geomagnetic pc-5 are studied by means of Alaskan data. The period of splitting echoes is just the same as that of simultaneous pc-5. The radar echoes are concentrated in the auroral zone in the morning hours, while they are rather widely distributed in latitude in the afternoon hours. In the morning the radar echoes are usually observed between Point Barrow and College, where the polarization of the geomagnetic field change is reversed. It is suggested that the precipitation of energetic charged particles causing the auroral radar echoes accompany the hydromagnetic oscillation in the magnetosphere, resulting in pc-5 at high latitudes. (auth)

19004 LONG-PERIOD GEOMAGNETIC OSCILLATIONS IN SOUTHERN HIGH LATITUDES. Teruo Sato (Japan Defence Agency, Tokyo). Rept. Ionosphere Space Res. Japan, 18: 173-82(1964).

Geomagnetic oscillations in southern high latitudes with periods of one to several minutes are studied, and their cause is considered. It is proposed that most long-period oscillations in high latitudes are caused by the ionospheric current which is related to the incidence of charged particles to the ionosphere. Long-period oscillations generated probably by hydromagnetic waves, such as those seen in middle and low latitudes (with fundamentally the same phase over the world), usually seem to be masked or deformed in high latitudes by local oscillations with large amplitudes of an ionospheric origin. (auth)

19005 SECULAR AND ANNUAL VARIATIONS IN THE PERIODS OF pc4 AND pc5. Yoshio Kato and Takao Saito (Tohoku Univ., Sendai). Rept. Ionosphere Space Res. Japan, 18: 183-7(1964).

The long-term variations in the periods of the pc-4 and pc-5 geomagnetic pulsations are analyzed. (D.C.W.)

19006 OBSERVATION OF pc1 AND pi1 BY A VISUAL-TYPE INDUCTION MAGNETOMETER AT THE MIDDLE LATITUDE STATION, ONAGAWA. Yoshio Kato and Takao Saito (Tohoku Univ., Sendai). Rept. Ionosphere Space Res. Japan, 18: 188-96(1964).

A visual-type induction magnetometer in use at the Onagawa Magnetic Observatory since 1962 is described, and the results of observations on the pearl, 3.5-sec band of pc-1 pulsation and pi-1 pulsation are presented in connection with results obtained at other high-latitude stations. (D.C.W.)

19007 ANNUAL AND SEMI-ANNUAL VARIATIONS IN THE EXOSPHERIC PLASMA DENSITIES DEDUCED FROM pc4 AND pc5. Takao Saito (Tohoku Univ., Sendai). Rept. Ionosphere Space Res. Japan, 18: 197-212(1964).

Reviewing mechanisms of the geomagnetic continuous pulsations, pc2, pc3, pc4 and pc5, it is deduced that the theory of hydromagnetic torsional standing oscillation of geomagnetic field-line for pc4 and pc5 will be applicable for estimating the density variation in the remote exosphere up to about 9 Re. The periods of both pc4 at Fredericksburg and pc5 at Byrd Station, whistler dispersion at Stanford, and drag of satellite Explorer I, are used. The annual and semi-annual variations of the plasma densities thus obtained show density decreases from 1958 to 1961 especially in the remote exosphere. Harmonic analyses of the annual variations indicate clearly the variations to be non-seasonal corresponding to the minimum density near June-solstice. These phenomena may be attributable to the decrease of the intensity of the solar radiation both due to the descending

solar activity during the analyzed period and due to the ellipticity of the earth's orbit. It is concluded from the decreasing rate of the secular and the annual components that the variations in the exospheric plasma densities are caused by the variation in the ionospheric electron densities. Semiannual variation is elucidated by a hypothesis, in which the seasonal inclination of the solar rotational axis is taken into account. The analyzed results are verified by referring to the B-type giant pulsation studied by Sucksdorff. (auth)

19008 PROPAGATION OF WEAK HYDROMAGNETIC DISCONTINUITY IN THE MAGNETOSPHERE AND THE SUDDEN COMMENCEMENT OF GEOMAGNETIC STORM. Tomikazu Namikawa (Osaka City Univ.), Taiichi Kitamura, Takashi Okuzawa, and Tohru Araki. Rept. Ionosphere Space Res. Japan, 18: 218-27(1964).

The propagation of Alfvén and fast shock waves from discontinuity surfaces in the magnetosphere was analyzed. The time differences in onset of sudden commencement at Point Barrow, College, and Sitka were calculated, assuming that the ssc onset time of declination of the geomagnetic field at high latitudes shows the arrival time of a transverse shock wave at the earth's surface. (D.C.W.)

19009 MAGNETOSPHERE AND ITS BOUNDARY. Tatsuzo Obayashi (Kyoto Univ.). Rept. Ionsphere Space Res. Japan, 18: 228-34(1964).

Some recent advances in magnetospheric studies are reviewed. The magnetospheric boundary, where the solar plasma interacts with the outer geomagnetic field, is discussed using various results of magnetic field and plasma measurements made by space probes. The observed spatial profile of the ionized particle density and its implication for magnetospheric physics are also given. (auth)

19010 SYMPOSIUM ON SOLAR-TERRESTRIAL RELATIONS, JUNE 19, 1964. Rept. Ionosphere Space Res. Japan, 18: 241-327(1964). (CONF-640617)

Separate abstracts were prepared for eight of the nine papers included. The other paper, on the 27-day recurrence tendency in cosmic-ray intensity, was previously abstracted for NSA 18: 44488. (D.C.W.)

For abstracts of individual papers see: 18672, 19011, 19012, 19013, 19014, 19015, 19016, and 19017.

19011 CORPUSCULAR STREAMS RELATED TO SOLAR M-REGIONS. Tatsuzo Obayashi (Kyoto Univ.). Rept. Ionosphere Space Res. Japan, 18: 245-59(1964).

Recent studies on 27-day recurrence geomagnetic disturbances and their associated phenomena during the decline phase of the present sunspot cycle are summarized. An identification of M-region with solar phenomena was made by evaluating the velocity of solar winds. Discussions are given on various existing hypotheses of corpuscular streams producing M-disturbances. (auth)

19012 A NEW INDEX OF GEOMAGNETIC PULSATION AND ITS RELATION TO SOLAR M-REGIONS. PART I. Takao Saito (Tohoku Univ., Sendai). Rept. Ionosphere Space Res. Japan, 18: 260-74(1964).

A geomagnetic index Kc3 for the pc3-type pulsation is introduced. It is verified that Kc3 is superior to geomagnetic Kp index as an indicator of solar wind, since the former shows a 14% higher correlation coefficient with the wind velocity observed by Mariner II. The solar M-regions deduced from the 27-day recurrence time-pattern of ΣKc3 from February, 1962 to June, 1964 are compared with solar active regions directly observed. In order to interpret the heliographical discrepancies of these regions obtained by superimposed method, a deflection hypothesis is proposed in which the solar wind is deflected on one side by a coronal field near the active region. (auth)

19013 RELATION BETWEEN THE SOLAR PLASMA VELOCITY AND THE GEOMAGNETIC ACTIVITY. Tadanori Ondoh (Radio Research Labs., Nakaminato, Japan) and Yukio Hakura. Rept. Ionosphere Space Res. Japan, 18: 287-90(1964).

The relation between geomagnetic activity and the solar plasma velocity is investigated for both solar active and quiet periods. (D.C.W.)

19014 STRUCTURE OF SOLAR PLASMA RESPONSIBLE FOR M-REGION STORMS. Yukio Hakura (Radio Research Labs., Tokyo). Rept. Ionosphere Space Res. Japan, 18: 291-4(1964).

The structure of the solar plasma responsible for M-region storms is discussed on the basis of a study of the relation between the plasma velocity and geomagnetic activity. M-region storms, M-region storms preceded by sudden commencements, and sudden commencements due to major flares with type-IV outbursts are considered. (D.C.W.)

19015 TRANSMISSION OF STORM SUDDEN COMMENCEMENTS THROUGH THE INTERPLANETARY SPACE; SHOCK WAVE MODE AND NON-SHOCK MODE. Atsuhiro Nishida (Tokyo Univ.). Rept. Ionosphere Space Res. Japan, 18: 295-306(1964).

The mode of transmission of agents for storm sudden commencements (SSC) from the sun to the earth is discussed in terms of the transmission speed relative to the solar wind which fills the interplanetary space. It is found that the rise time of an SSC on the ground depends on the SSC transmission speed relative to the solar wind, in such a manner that is consistent with the idea that some SSC's are caused by shock waves (shock wave mode), while others result from small amplitude waves or contact discontinuities (non-shock mode). The magnitude of a decrease in Dst in the storm main phase is greater after a shock wave mode SSC than after a non-shock mode SSC. This is in agreement with the idea that SSC's are transmitted when ejected solar clouds push the interplanetary medium outwards and that storm main phases occur when these clouds cover the earth's magnetosphere. (auth)

19016 RECURRENCE TENDENCY OF GEOMAGNETIC DISTURBANCES AND ITS ASSOCIATION WITH THE SLOWLY VARYING COMPONENT OF MICROWAVE SOLAR RADIATION. Tetsuo Goh (Radio Research Labs., Nakaminato, Japan). Rept. Ionosphere Space Res. Japan, 18: 307-13(1964).

The relation between centers of solar activity and geomagnetic disturbances with a 27-day recurrence tendency was investigated by calculating the autocorrelation functions of the slowly varying component of solar radioemission and the ΣK index, as well as the cross correlation functions between these parameters. (D.C.W.)

19017 RELATION BETWEEN THE RECURRENT MAGNETIC DISTURBANCE AND THE SOLAR PHENOMENA. Yukio Nojima, Yoshiteru Nakagomi, and Shingo Nagasawa (Tokyo Univ.). Rept. Ionosphere Space Res. Japan, 18: 319-27(1964).

The 27-day recurrence tendency was observed in the daily sums of the geomagnetic Kp and pc 2, 3 indices from October 1962 to January 1964. The 27-day diagram of these indices was compared with the dates of the central meridian passages of Ca plage and intensive green coronal line. (D.C.W.)

Low Temperature Physics

Refer also to abstracts 18331, 18599, 18601, and 18622.

19018 (ORNL-TM-1083) EXPERIMENTAL SIMULATION OF LARGE, HIGH-FIELD, SUPERCONDUCTING MAGNET OPERATION. W. F. Gauster and D. L. Coffey (Oak Ridge National Lab., Tenn.). Mar. 23, 1965. Contract W-7405-eng-26. 46p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Sample coils of large diameter, but with small cross sectional areas, have been tested in applied external fields up to 75 kilogauss (generated by a conventional 7-Mw water-cooled magnet with 6½-inch working diameter). By an appropriate choice of sample cross sections, it can be assumed that the "large diameter-small cross section sample coils" will approximately reproduce the electrical, magnetic, and thermal conditions in a corresponding part volume within a large superconducting coil. It is hoped that the evaluation of the test results with these sample

coils will produce meaningful data, which can be applied to the design of large superconducting magnet coils. With sample coils (3.75 in. OD, 2.225 in. ID, 0.775 in. length, 2250 turns of copper clad, nylon insulated, Nb–25% Zr wire), $I_c - H_c$ curves were obtained which had minima for external fields of about +3 kilogauss and about –12 kilogauss, and maxima at around +15 kilogauss and –30 kilogauss. With zero external field, the quenching currents scattered between 26 and 46 amps. $|\bar{B}|$ = constant contours show large volumes with $|\bar{B}| \leq 5$ kilogauss for the two mentioned minimum points of the quenching characteristic and for zero external field. This is in qualitative agreement with preliminary flux jump measurements. (auth)

19019 (UCRL-11901) I. SIMILARITY PRINCIPLE AND ISOTOPE EFFECT IN SUPERCONDUCTING INDIUM. II. LOW-TEMPERATURE HEAT CAPACITY OF NIOBIUM (thesis). Nail Mehmet Senozan (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 1965. Contract W-7405-eng-48. 105p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Theories predict that the critical field curves of the isotopes of a superconductor are similar if the lattice contributions, C_{ln} and C_{ls}, to the normal and superconducting state heat capacities of this superconductor are the same. Recent measurements have indicated that the low temperature heat capacity of indium is anomalous; C_{ls} is about 15% smaller than C_{ln}. In order to see whether this anomaly is reflected in the critical fields as the theories predict critical field measurements between 1°K and the transition temperature 3.4°K were made on five isotopically enriched indium specimens. It was found that the critical fields are similar within one part in 600 and, furthermore, that the isotope effect is present—the transition temperature, T_c, being dependent on the isotopic mass, M, as $T_c \alpha M^{-\frac{1}{2}}$. Also an attempt was made to investigate whether the indium anomaly is unique or whether it is common to other superconductors. Niobium was chosen because its high transition temperature, 9.2°K, allows one to work at very low reduced temperatures where, according to the BCS theory, the electronic contribution to the heat capacity of the superconducting state becomes negligible and a comparison of the lattice terms is possible. Using a ^{3}He calorimeter measurements between .25 and 25°K were made on a single crystalline specimen of niobium in which the total impurities were less than 80 parts per million. It was found that at low temperatures ($T \lesssim 5$°K) the normal state heat capacity, C_n, is best represented as $C_n = 7.85 + 0.0915\ T^3 + 0.0010\ T^5$ millijoules/mole degree. The behavior of the superconducting state heat capacity, C_s, is striking. At very low temperatures it does not approach C_{ln}, the normal state lattice heat capacity; in fact, it does not have a T^3 dependence. The results are best understood by assuming equal lattice contributions in the normal and superconducting state heat capacities. The superconducting state heat capacity can then be written as $C_s = C_{es} + 0.0915\ T^3 + 0.0010\ T^5$ millijoules/mole degree where C_{es} is best represented by $C_{es} = (7.85\ T_c)(7.85\ e^{-1.43(T_c/T)}) + 2.6 \times 10^{-3}\ e^{-0.053(T_c/T)}$ millijoule/mole degree. This suggests that the energy gap in niobium is very strongly anisotropic. (auth)

19020 LIQUID HELIUM. Lyle B. Borst (State Univ. of New York, Buffalo). Am. Scientist, 52: 431-46(Dec. 1964).

The unique properties of liquid He are discussed, and a new theory is proposed as an extension of the Debye theory to account for its behavior at the lambda point (2.18°K). Pairs of atoms are assumed to rotate and these rotational excitations are strongly coupled to the acoustical vibrations of the Debye theory. The rotation-vibration excitations, called helions, are analogous to the rotons of Landau and the vortices of Feynman. They account quantitatively for the thermodynamic anomalies in liquid He, predict a lambda point, account for the lambda point in ^{3}He–^{4}He solutions, and yield dispersion relations for the observed form. The theory suggests that the minimum of the dispersion curve is another expression of the dissociation occurring at the lambda temperature. If this is true, then the minimum of the dispersion curve should follow the lambda temperature as a function of applied external pressure and in ^{3}He–^{4}He solution. The superfluid is that fraction of the liquid corresponding to neither acoustic nor vibration-rotation excitations, or that fraction in the zero-momentum or ground state. As such, the superfluid is a continuum and its characteristics imply the absence of discrete atoms. It is suggested that this theory of excited states may be general for monatomic noble gases, limited only by the freedom of the paired atoms to rotate in the cell of their neighbors. Helium-6, a radioisotope of 0.8-sec half life, should form a superfluid if prepared in high concentration. An estimate indicates that the lambda point of the pure material would be expected near 1.5°K. For the next heavier noble gas, Ne of at. wt 20, the de Broglie wave length would be less than half that of He at a given temperature and the quantum mechanical wave interference should be considerably less. The combination of smaller nearest-neighbor distance and greater at. wt gives a rotational constant one-quarter that of He, so that the Debye fluid, if it forms, would be found only below 0.2°K. The existence of a lambda point cannot be predicted with assurance since the rotational state falls below the temperature at which Debye modes are numerous and the requirement for strong coupling may not be necessary. Moreover, the theory is that of a liquid with no long-range order, so liquid Ne would have to be supercooled below its normal freezing point of 25°K. If, however, this experimental difficulty can be overcome, superfluid characteristics might well be observed at temperatures of a few tenths of a degree. (BBB)

19021 SUPERCONDUCTING MAGNET SYSTEMS OFFER NEW DESIGN POSSIBILITIES. D. L. Atherton and I. D. McFarlane (Ferranti Electronics, Toronto). Can. Electron. Eng., 9: No. 1, 36-40(Jan. 1965).

The properties and uses of hard and soft superconductors are outlined, and measurements on the current-carrying capacity of some hard superconductors are summarized. The advantages and fabrication of superconducting solenoids are then discussed, together with the design and performance of superconducting d-c generators. (D.C.W.)

19022 QUASI-SPIN TREATMENT OF JOSEPHSON TUNNELING BETWEEN SUPERCONDUCTORS. P. R. Wallace and M. J. Stavn (McGill Univ., Montreal). Can. J. Phys., 43: 411-17(Mar. 1965).

It is shown that the quasi-spin method in superconductivity permits a simple and direct calculation of the effects (which were first discussed by Josephson) associated with tunneling of electron pairs between superconductors across an insulating junction. (auth)

19023 LANDAU APPROXIMATION FOR THE CRITICAL INELASTIC MAGNETIC SCATTERING OF NEUTRONS BY A FERROMAGNET. INELASTICITY OF COLLISIONS AT THE CURIE POINT. Joseph Seiden (Faculte de Sciences, Orsay, France). Compt. Rend., 250: 457-60(Jan. 11, 1965). (In French)

A new method is introduced for the determination of the energy distribution of neutrons scattered by a ferromagnet in the vicinity of the Curie temperature. It is shown that the scattering of neutrons even at the Curie temperature remains inelastic. (tr-auth)

19024 STUDY BY ELECTRIC RESISTIVITY OF THE NORMAL STATE-SUPERCONDUCTOR STATE TRANSITION FOR TINS OF DIFFERENT PURITIES. Robert Reich and Louis Renucci (Centre National de la Recherche Scientifique, Vitry, France). Compt. Rend., 260: 545-8 (Jan. 11, 1965). (In French)

The effect of the purity on the normal-to-superconducting transition was studied by a determination of the variation of the ratio of the electrical resistivities $\rho_{T°K}/\rho_{4.245°K}$ at temperatures below 4.245°K. The curves obtained are given and show that the transition occurs later and later as the purity of the metal decreases. (J.S.R.)

19025 LIMITING MAGNETIC FIELDS FOR HIGH-FIELD SUPERCONDUCTIVITY. K. M. Ralls, R. M. Rose, and J. Wulff (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 36: 1295-8(Apr. 1965).

In order to calculate the limiting magnetic field for superconductivity of a type II superconductor, the free-energy contributions of the Abrikosov mixed state and the electron

spin paramagnetism are combined. The solutions which result are applied to the niobium–zirconium alloys system and compared with the available resistive critical field data, as a function of composition. The calculated curve is generally closer to the experimental curve than either the paramagnetic limit or H_{c2} alone, and rather good agreement is obtained for niobium-rich alloys. (auth)

19026 DISCONTINUITIES IN THE DRIFT VELOCITY OF IONS IN LIQUID HELIUM. G. Careri, S. Cunsolo, P. Mazzoldi, and M. Vicentini-Missoni (Universita, Rome). Lectures Many-Body Probl., 2: 11-14(1964).

The behavior of the drift velocity of electric elementary charges in liquid He at about 1°K was studied as a function of the applied electric field, using time-of-flight and heat-flush methods. Results of the measurements are summarized. The anomalous behavior of the ions is explained tentatively as due to the formation of a quantized vortex ring in the superfluid; this ring remains bound to the moving ion while interacting with the roton sea to create a new source of dissipation. (M.J.T.)

19027 SPECIAL EFFECTS IN SUPERCONDUCTIVITY. P. W. Anderson (Bell Telephone Labs., Inc., Murray Hill, N. J.). Lectures Many-Body Probl., 2: 113-35(1964).

The Josephson tunneling effect—weak superconductivity is described, using the BCS theory, and equations for the energy gaps and Josephson current are derived. Some implications of the effect are discussed in terms of observable phenomena. The connection of the Josephson effect to the general many-body theory of condensed states and to broken symmetry is considered. (M.J.T.)

19028 SUPERCONDUCTIVITY WITH p- AND d-WAVE PAIRING. R. Balian (Centre d'Etudes Nucleaires, Saclay, France). Lectures Many-Body Probl., 2: 147-58(1964).

The properties of a hypothetical superconducting system, in which the pairs are formed with angular momentum different from zero, are surveyed, and the possibility of the existence of such a system in metals and liquid ^{3}He is considered. P-wave pairing is discussed, with a derivation of the gap equation, using Green functions, and this model is compared with the BCS case. D-wave pairing is described, using the method of Gorkov and Galitskii, and the adequacy of the model for explaining observations is discussed. (M.J.T.)

19029 TEMPERATURE-DEPENDENT RANDOM PHASE APPROXIMATIONS FOR THE HEISENBERG FERROMAGNET. G. Horwitz (Hebrew Univ., Jerusalem and Weizmann Inst. of Science, Rehovoth, Israel). Lectures Many-Body Probl., 2: 179-201(1964).

The general nature of the temperature-dependent random phase approximation, yielding at low temperatures the collective spin excitations and in the vicinity of the Curie temperature (T_c) a correction to the Weiss molecular field approximation, is described. Many of the results are then developed by the method of approximate decoupling of the equations of motion. The disagreement between the original version of the RPA calculations and Dyson's results for the corrections to the spin-wave contributions at low temperatures is considered. The behavior of the RPA results above T_c is examined, and the relation of this question to the characterization of the high-temperature limit of the RPA as a high density expansion is studied. (M.J.T.)

19030 THE THERMODYNAMIC PROPERTIES OF SOLID AND FLUID HELIUM-3 AND HELIUM-4 ABOVE 3°K AT HIGH DENSITIES. J. S. Dugdale and J. P. Franck (National Research Council, Ottawa). Phil. Trans. Roy. Soc. London, Ser. A, 257: No. 1076, 1-29(Nov. 19, 1964).

Measurements were made of the specific heat at constant volume of solid ^{3}He from 3°K up to the melting point at a number of different densities corresponding to pressures up to 2000 atm. The measurements were extended through the melting region at constant volume up to 29°K in the fluid phase. For comparison similar measurements were made on ^{4}He at four different densities. By combining these data with the p-V-T data of Grilly and Mills, the complete thermodynamic properties of the solids were derived in the relevant pressure and temperature range. The results can be understood semi-quantitatively in terms of the zero-point energy of the solids and a quasi-harmonic model of the lattice vibrations. A brief discussion of the specific heat of the fluid phase is also given. (auth)

19031 THE TEMPERATURE DEPENDENCE OF THE "LOWER" CRITICAL FIELD FOR SOME NON-IDEAL TYPE II SUPERCONDUCTORS. R. D. Blaugher (Westinghouse Electric Corp., Baltimore). Phys. Letters, 14: 181-2(Feb. 1, 1965).

Magnetization measurements, which were performed in a superconducting magnet between 1.5 and 4.2°K, and resistivity measurements, which were determined by the four-probe method, are reported for b-c-c solid solutions alloys of Ti-V and Ti-Mo. It is shown that the magnetization peak for Ti-V(38.5, 48.5, 58.5V) follows a $t^2(t = T/T_c)$ temperature dependence. (L.B.S.)

19032 SUPERCONDUCTIVITY OF LANTHANUM NITRIDES. J. J. Veyssie, D. Brochier, A. Nemoz, and J. Blanc (Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France). Phys. Letters, 14: 261-2(Feb. 15, 1965). (In French)

The susceptibility of a sample of LaN was measured between 0.76 and 4.2°K in a weak alternating field of frequency 180 Hz, and the complete magnetization cycle to 0.76°K was traced. The results indicate the presence of a type-II superconductor, with transition temperature around 1.35°K. (M.J.T.)

19033 SUPERCONDUCTIVITY IN Pb-Al SUPERIMPOSED FILMS. J. J. Hauser and H. C. Theuerer (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Letters, 14: 270-1(Feb. 15, 1965).

The preparation of Pb-Al superimposed films is described. Theoretical and experimental curves are presented of the transition temperature for a constant aluminum film thickness as a function of the lead film thickness. The close agreement establishes the validity of the De Gennes theory. (L.B.S.)

19034 THERMAL CONDUCTIVITY OF A THIN SUPERCONDUCTING FILM WITH PARAMAGNETIC IMPURITIES. K. H. Bennemann (Technische Hochschule, Karlsruhe, Ger.). Phys. Letters, 14: 273-5(Feb. 15, 1965).

Equations are derived for the ratio of thermal conductivities in superconducting and normal states, K_s/K_n. A family of curves for K_s/K_n versus T/T_c for different values of β is presented. (L.B.S.)

19035 INFLUENCE OF A TRANSPORT CURRENT ON THE MAGNETIZATION OF SUPERCONDUCTING INDIUM-LEAD ALLOYS. W. F. Deuyvesteyn (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Letters, 14: 275-6(Feb. 15, 1965).

Magnetization measurements were made on In-Pb wires at 2.65°K for the case of no applied current, and the magnetic induction was measured for the case where the field is first applied and then the current, $(H \rightarrow I_t)$. The influence of the transport current on the magnetization is discussed for $H \rightarrow I_t$ and $I_t \rightarrow H$, within the framework of calculations for a flat plate with the external field parallel to the largest surface and $H_t \perp H$. A linear relation was found between B and I_t for $H \rightarrow I_t$. (L.B.S)

19036 THERMODYNAMICS OF SUPERCONDUCTORS OF THE SECOND KIND. G. Fournet (L.C.I.E., Fontenay-aux-Roses, France). Phys. Letters, 14: 279-80(Feb. 15, 1965). (In French)

A distinction is made between macroscopic and Lorentz microscopic fields, and an expression for the free energy of normal and type-I superconducting samples is obtained. The free energy of a type-II superconductor and the macroscopic magnetic field and magnetization intensity are derived. The magnetic behavior of a superconducting body is studied, assuming the externally imposed magnetic field and the field in the absence of the superconducting body are equal, and neglecting effects of free surfaces of the body. An equation is obtained for the critical field. (M.J.T.)

19037 STUDY OF THE CRITICAL FIELD H_{c3} IN A CYLINDRICAL GEOMETRY. D. Saint-James (Centre

d'Etude Nucleaires, Saclay, France). Phys. Letters, 15: 13-15(Mar. 1, 1965). (In French)

The critical field H_{c3} of a superconducting cylinder is calculated for a field parallel to the axis as function of the radius of the cylinder. The results are qualitatively different from those obtained previously for a plate. The difference arises from the flux contained in the cylinder. In particular, the limiting value $H_{c3} = 1.69\ H_{c2}$ is obtained only for diameters about 30 times as large as the thickness of the corresponding plate. (M.J.T.)

19038 SPECIFIC HEAT OF TYPE II SUPERCONDUCTORS. L. J. Vieland (RCA Labs., Princeton, N. J.). Phys. Letters, 15: 23-4(Mar. 1, 1965).

The specific heat of a type-II superconductor in a magnetic field is derived for fields substantially below H_{c2}, using the Abriksov theory. The effect of the temperature dependence of the susceptibility on the specific heat is examined. Data on V-5%Ta are considered and compared with theoretical values. (M.J.T.)

19039 HALL EFFECT MEASUREMENTS ON TYPE II SUPERCONDUCTORS. A. K. Niessen and F. A. Staas (Philips Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Letters, 15: 26-8(Mar. 1, 1965).

Results of Hall-effect measurements on 50%Nb-50%Ta sheets at 1.3 to 4.2°K are presented, giving transverse and longitudinal voltages and Hall angle as functions of magnetic field. Two models explaining the resistance in type-II superconductors as due to vortex motion are discussed. Results of measurements on a Pb foil are also mentioned. (M.J.T.)

19040 ON THE MUTUAL FRICTION IN A SUPERFLUID. S. V. Iordanskii (Steklov Mathematical Inst., Moscow). Phys. Letters, 15: 34-5(Mar. 1, 1965).

An expression for the mutual friction force in a rotating, weakly interacting Bose gas is presented. The expression is transformed to one containing a transport cross section, taking into account singularities of the interaction of the excitation with the vortex line. Calculations of the roton and phonon parts of the mutual friction were performed, and the result for the Hall and Vinen coefficients is given. (M.J.T.)

19041 ON THE SECOND-ORDER PHASE TRANSITION IN A FERMI SYSTEM. W. Weller (Karl-Marx Universitat, Leipzig). Phys. Letters, 15: 35-6(Mar. 1, 1965).

The possible existence of a singularity in the specific heat of a superconductor (as a function of temperature) during the transition from the normal to the superconducting phase is investigated, using general quantum statistical arguments. It is concluded that no singularity is possible in the Fermi case. Fermi systems such as electrons in a metal or liquid ^{3}He are considered. (M.J.T.)

19042 HYDRODYNAMICAL EQUATIONS FOR THE SUPERFLUID FERMI LIQUID AND TWO PARTICLE GREEN FUNCTION. Z. Galasiewicz (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 15: 39-40 (Mar. 1, 1965).

The temperature of Green functions are obtained as the variational derivatives of the hydrodynamical expectation values with respect to the sources, for the sources equal to zero, considering a system of Fermi particles with pairing forces in the presence of external pair sources and using the linearized acoustic equations for infinitesimal sources. It is found that the two-particle Green functions have poles corresponding to two kinds of elementary excitations: first and second sound quanta. (M.J.T.)

19043 VORTICES IN AN IMPERFECT BOSE GAS. I. THE CONDENSATE. Alexander L. Fetter (Univ. of California, Berkeley). Phys. Rev., 138: A429-37(Apr. 19, 1965).

A theoretical study of rectilinear vortices in an imperfect Bose gas shows a close correspondence with classical hydrodynamics. The energy and momentum of a vortex pair in an unbounded fluid are calculated. The similarity between a vortex pair and a vortex ring leads to an estimate of the critical velocity v_c of liquid He II in a tube of radius R that includes the effect of the walls $v_c = C\hbar/2mR$, where C is a constant of order unity. A variational treatment of a system of many identical vortices in a container shows that the energy is lowest for a uniform distribution, and that the number of vortices per unit area ν agrees with Feyman's result $\nu = 2m\omega/h$. In the classical limit ($h \to 0$), the angular momentum and energy approach the values for solid-body rotation. (auth)

19044 SURFACE TENSION OF LIQUID He^4. K. R. Atkins and Y. Narahara (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 138: A437-41(Apr. 19, 1965).

The surface tension of liquid ^{4}He was measured down to 0.35°, using the capillary-rise method. The results are consistent with the theory that this temperature variation is mainly due to the excitation of surface modes similar to capillary waves. However, the results do not exclude an alternative theory, due to Singh, which considers the effect of the surface on the wave functions of an ideal degenerate Bose-Einstein gas. At the λ point, a discontinuity (or at least a very rapid variation) of the first derivative with respect to temperature was observed. (auth)

19045 GROUND STATE OF LIQUID He^4. W. L. McMillan (Univ. of Illinois, Urbana). Phys. Rev., 138: A442-51(Apr. 19, 1965).

The properties of the ground state of liquid ^{4}He are studied using a variational wave function of the form $\Pi_{i<j} f(r_{ij})$. The Leonard-Jones 12-6 potential is used with parameters determined from the gas data by deBoer and Michiels. The configuration space integrals are performed by a Monte Carlo technique for 32 and 108 atoms in a cube with periodic boundary conditions. With $f(r) = \exp[-(2.6\text{Å}/r)^5]$, the ground-state energy is found to be -0.78×10^{-15} ergs/atom, which is 20% above the experimental value. The liquid structure factor and the two-particle correlation function are in reasonably good agreement with the x-ray and neutron scattering experiments. (auth)

19046 LOW-TEMPERATURE ELECTRICAL RESISTIVITY AND SUPERCONDUCTING TRANSITION TEMPERATURE OF INDIUM–MANGANESE ALLOYS. Douglas L. Martin (National Research Council, Ottawa). Phys. Rev., 138: A464-7(Apr. 19, 1965).

The solution of small amounts of manganese in indium produces a rapid depression of the superconducting transition temperature, but the effect is found to saturate for larger concentrations. The electric resistance of the alloys is found to increase monotonically with increasing temperature. These observations suggest that manganese dissolved in indium does not have a localized magnetic moment. (auth)

19047 EFFECT OF PRESSURE ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF LANTHANUM. W. E. Gardner and T. F. Smith (Univ. of California, San Diego, La Jolla). Phys. Rev., 138: A484-6(Apr. 19, 1965).

The variation of the superconducting transition temperature of h-c-p lanthanum was measured as a function of pressure up to 10 kbar. An approximately linear increase of T_c with applied pressure was observed ($\partial T_c/\partial P \sim 14 \times 10^{-5}$ °K bar^{-1}). The relation of this behavior to two recently proposed theories for the superconductivity of lanthanum is discussed. (auth)

19048 ABSENCE OF SUPERFLUIDITY IN LOW-PRESSURE LIQUID He^3 ABOVE 0.0035°K. W. R. Abel, A. C. Anderson, W. C. Black, and J. C. Wheatley (Univ. of Illinois, Urbana). Phys. Rev. Letters, 14: 129-31 (Feb. 1, 1965). (COO-1198-235)

The nuclear susceptibility and self-diffusion coefficient for magnetization were measured in low-pressure ^{3}He as a function of magnetic temperature below 10 millidegrees. It was concluded that there is no transition to a superfluid state in ^{3}He above 3.5 millidegrees. (D.C.W.)

19049 STUDY OF THE EXCHANGE INTEGRAL OF CRYSTALLINE ^{3}He AT 0°K. L. H. Nosanow and William J. Mullin (Univ. of Minnesota, Minneapolis). Phys. Rev. Letters, 14: 133-6(Feb. 1, 1965).

A cluster expansion for the ground-state energy is obtained, including the effects of exchange. An expression for the exchange integral is derived, taking into account the effect of pair correlations. The exchange integral is calculated as a function of the nearest-neighbor distance for both the bcc and hcp structures of crystalline ^{3}He. The effects of pair correlations on the exchange integral are studied. (D.C.W.)

19050 SUPERCONDUCTIVITY IN GRAPHITIC COMPOUNDS. N. B. Hannay, T. H. Geballe, B. T. Matthias, K. Andres, P. Schmidt, and D. MacNair (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 14: 225-6 (Feb. 15, 1965).

Superconductivity was observed in compounds prepared by heating highly purified alkali metals with pyrolytic graphite in an evacuated tube. Typical formulas for the compound are C_8 A (A = K, Rb, or Cs). The layer structure of graphite is preserved, the alkali metal atoms lying in layers alternating with the graphite carbon layers. The transition temperatures ranged from 0.020 to 0.135°K for Cs; from 0.023 to 0.151°K for Rb; and up to 0.55°K for K. The highest transition temperatures were observed for compounds prepared with excess alkali metal present. (D.C.W.)

19051 INERTIAL MASS OF A MOVING FLUXOID. H. Suhl (Univ. of California, San Diego, La Jolla). Phys. Rev. Letters, 14: 226-9(Feb. 15, 1965).

It is shown that a time-dependent form of the Ginsburg-Landau theory gives rise to an inertial mass per unit length of flux line. The resulting acceleration term is compared with the damping term investigated by Barden and Stephen. The result indicates that the relaxation time of a fluxoid is less than 10^{-12} sec. (D.C.W.)

19052 MICROWAVE PHONON-ASSISTED TUNNELING IN SUPERCONDUCTORS. Edward Lax and Frank L. Vernon, Jr. (Aerospace Corp., El Segundo, Calif.). Phys. Rev. Letters, 14, 256-8(Feb. 22, 1965).

The current-voltage characteristics of Al–Al_2O_3–Pb, Al–Al_2O_3–Sn, Pb–Al_2O_3–Sn, and Pb–Al_2O_3–Pb junctions deposited on one end of quartz rods in which phonons were generated by a microwave cavity around the other end of the rod were measured. An enhancement of the tunneling current due to microwave phonons was observed. (D.C.W.)

19053 NEUTRON INELASTIC SCATTERING FROM LIQUID HELIUM AT SMALL MOMENTUM TRANSFERS. A. D. B. Woods (Chalk River Nuclear Labs., Chalk River, Ont.). Phys. Rev. Letters, 14: 355-6(Mar. 8, 1965).

The distributions of neutrons (4.05 Å) scattered from liquid helium were measured as a function of the energy change at three different scattering angles and at temperatures between 1.5 and 4.2°K. The phonon velocity calculated as a function of temperature from the observed neutron groups was compared with the measured velocity of sound and the theory of Hohenberg and Martin. The slope of the dispersion curve is almost independent of temperature, in disagreement with the predictions of the theory. (D.C.W.)

19054 SUPERCONDUCTING TUNNELING AT HIGH MAGNETIC FIELDS AND POSSIBLE EVIDENCE FOR GINZBURG SURFACE SUPERCONDUCTIVITY. Myron Strongin, Arthur Paskin, O. F. Kammerer, and M. Garber (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 14: 362-5(Mar. 8, 1965).

The resistance (dv/di)–voltage characteristics of Pb–Al_xO_y–Al junctions in magnetic fields of 1 to 25 gauss were measured at temperatures ranging from below 1°K to above 2.2°K. The results indicate superconductivity persisting to about 1.8°K with a maximum critical field of 29 kgauss at 1°K and an equivalent thermodynamic bulk critical field of 200 gauss at 0°K. It is proposed that the observations can be attributed to Ginzburg surface superconductivity. (D.C.W.)

19055 THE ACOUSTIC IMPEDANCE OF LIQUID HELIUM-3. B. E. Keen, P. W. Matthews, and J. Wilks (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 284: 125-36(Feb. 9, 1965).

Measurements were made of the acoustic impedance (Z) of liquid ^{3}He under its saturated vapor pressure in the temperature range from 0.035 to 0.6°K. A 1000-Mc/s sound wave is propagated along the axis of an X-cut quartz crystal and undergoes many reflections from each end of the crystal. Values are obtained for the reflection coefficient at an interface between quartz and liquid ^{3}He by comparing the rate at which the signal decays in the crystal, with and without liquid ^{3}He present on the ends. These values then lead directly to the acoustic impedance (Z) of the liquid. Usually, Z/ρ (where ρ is the density) should be equal to the velocity of sound, and above 0.1°K this is found to be so. However, at about 0.1°K the value of Z/ρ increases abruptly, and at lower temperatures has a value about 10% greater. This result is in good agreement with Landau's theory of a Fermi liquid, which relates the change in impedance with the propagation of a new mode of sound, the so-called zero-sound. (auth)

19056 USE OF PULSED FIELDS FOR MEASURING CRITICAL CURRENTS OF HIGH FIELD SUPERCONDUCTORS. H. Benz, R. Fasel, and E. Fischer (Eidgenossische Technische Hochschule, Zurich). Rev. Sci. Instr., 36: 562-3(Apr. 1965).

It was found that it is possible to obtain very complete information about the behavior of high field superconductors using field pulses about 100 msec in length if the current is also applied as a short pulse near maximum field. This technique was used to measure critical currents in hairpin-shaped NbZr wires of 0.25 mm thickness containing 25% Zr. (C.E.S.)

19057 STRONG MAGNETIC FIELD PULSES BY MEANS OF SUPERCONDUCTOR GATES. C. Hansson and B. Jeppsson (Chalmers Inst. of Tech., Gothenburg, Sweden). Rev. Sci. Instr., 36: 563-4(Apr. 1965).

A method is described which allows strong magnetic field pulses with short risetime and excellent stability of the maximum magnetic field value. The method utilizes a superconducting gate in the form of a cylinder of PbBi. (C.E.S.)

19058 112 kG SUPERCONDUCTING MAGNET. W. B. Sampson (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr., 36: 565-6(Apr. 1965). (BNL-8795)

A superconducting solenoid which is capable of producing a magnetic field in excess of 110 kgauss was constructed. The coil was made from Nb_3Sn coated stainless steel ribbon and is made up of four concentric sections, each of which can be separately energized. (C.E.S.)

19059 CRITICAL FIELDS OF Sn In THIN FILMS. J. P. Burger, G. Deutscher, E. Guyon, and A. Martinet (Service de Physique des Solides, Faculte des Sciences, Orsay, France). Solid State Commun., 2: 101-3(Apr. 1964).

Thin hollow cylinders of Sn-In alloys (type II superconductors) were studied in the field range $H_{C2} < H < H_{C3}$ where the superconductivity is restricted to a surface layer. With these cylinders both H_{C2} and H_{C3} are determined independently by resistive and by magnetic measurements. The transitions are much sharper than in the corresponding bulk samples. The resulting H_{C3}/H_{C2} ratio is in good agreement with the theoretical value. Preliminary results on the angular dependence of the upper limiting field have also been obtained. (auth)

19060 THE INFLUENCE OF CURRENTS AND MAGNETIC FIELDS ON THE SUPERCONDUCTING PROPERTIES OF Nb_3Sn, V_3Ga, AND V_3Si DIFFUSION LAYERS. G. Meyer and H. Wizgall (Universität, Giessen, Ger.). Z. Physik, 183: 412-23(1965). (In German)

For diffusion layers of Nb_3Sn, V_3Ga, and V_3Si on niobium and vanadium wires, respectively, the transition to superconductivity was measured at various currents in longitudinal and transverse magnetic fields. Current and field shift the transition curve to lower temperatures, except near the onset of superconductivity where the core of the wire influences the transition. The critical current vs

temperature curves are linear at higher currents, the critical field curves are bended. The results are explained by local variations of the transition temperature due to inhomogeneities and by a displacement of the current paths under the influence of the Lorentz force. For very thin diffusion layers an influence of thickness on the transition temperature was observed. In addition quenching curves of the diffusion layers were measured. The shape is in accordance with the model of Kim and coworkers. The absolute values and deviations at higher fields are discussed. A deduction of the critical values at low temperatures from measurements near the transition is possible. (auth)

19061 THEORY OF SUPERCONDUCTIVITY. G. Rickayzen. Interscience Monographs and Texts in Physics and Astronomy. Volume XIV. New York, Interscience Publishers, 1965. 495p.

Mathematical formulations of important theories of superconductivity are given. Electrons in solids, lattice vibrations, and their interaction are described. The main part of the microscopic BCS theory and its developments are discussed and compared with experiment, with consideration of the superconducting ground state, superconductor thermodynamics, electrodynamics, impurity effects, flux quantization, Ginzburg-Landau equations, and electron tunneling into superconductors. Modifications caused by taking the long-range Coulomb interaction into account are summarized. The application of the BCS theory to other Fermi superfluids—liquid ^{3}He and the superfluid model of the nucleus—is briefly recounted. 292 references. (M.J.T.)

19062 TEMPERATURE DEPENDENT ULTRASONIC ABSORPTION IN TYPE II SUPERCONDUCTORS. Lewis T. Claiborne, Tore Olsen, and Norman G. Einspruch (Texas Instruments, Inc., Dallas). 8p. (CONF-640803-3)

From Conference on the Physics of Type II Superconductivity, Cleveland.

Recent studies of the oscillatory temperature dependence of the compressional ultrasonic wave attenuation in type II superconductors are discussed. Two previously proposed simple models for the resonant absorption are analyzed in terms of the experimental observations on polycrystalline Nb–Zr, Nb–Mo, La, and Sn. The possibility of second sound in type II superconductors as a mechanism for the dissipation of ultrasonic energy is considered as well. (auth)

Neutron Physics

See also REACTOR TECHNOLOGY — Criticality Studies.

Refer also to abstracts 19053, 19087, and 19137.

19063 (AWRE-O-97/64) THE CALCULATION OF GROUP AVERAGED NEUTRON CROSS SECTIONS: GALAXY 3 FACILITIES AVAILABLE IN S2 (FORTRAN) LANGUAGE FOR THE IBM 7030 (STRETCH) COMPUTER. W. M. M. Kerr, K. Parker, and D. V. J. Williams (Atomic Weapons Research Establishment, Aldermaston (England)). Mar. 1965. 73p. Dep.(mn).

Processing of BCD tapes generated by the IBM 7090 version of GALAXY, to give input tapes for the neutronics programs STRAINT (one dimensional S_n transport theory), TURTLE (two dimensional S_n transport theory), and DUNDEE (perturbation theory) is described. The format of these input tapes and of the BCD tape are given in detail and the facilities of combination, condensing, mixing, adjustment, and substitution that which can be applied to calculated group cross sections are described. An overall flow diagram and input instructions are given. (auth)

19064 (MMPP-FRPC-64-1) RECENT APPLICATIONS OF NEUTRON TRANSPORT THEORY. P. F. Zweifel (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering). 1964. Contract AT(11-1)-1372. 65p. (CONF-640615-1) Dep.(mn); $3.00(cy), 2(mn) CFSTI.

From Fast Reactor Physics Conference, Ann Arbor, Mich.

A brief review is given of the use of a set of (singular) normal modes in order to solve the neutron transport equation in a manner analogous to the methods used in other problems of mathematical physics. The one-speed, one-dimensional, time-independent neutron transport equation is considered. Full-range applications, half-range applications, two half-space applications, anisotropic scattering applications, and time-dependent applications are discussed. (C.E.S.)

19065 (WAPD-TM-395) THE UTILIZATION OF THE NEUTRON DIFFUSION PROGRAM PDQ-5. L. A. Hageman and C. J. Pfeifer (Bettis Atomic Power Lab., West Mifflin, Pa.). Jan. 1965. Contract AT(11-1)-Gen-14. 721p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The PDQ-5 program provides a discrete numerical approximation to the two-dimensional, time-independent neutron diffusion problem. A general description is given of the computational methods employed by the program, and the significance of the output numbers is defined and discussed. Some numerical examples are given. (auth)

19066 INVESTIGATION OF NEUTRON MODERATION IN BERYLLIUM AND BERYLLIUM OXIDE BY PULSE METHOD. I. F. Zhezhurin. At. Energ. (USSR), 18: 127-35(Feb. 1965). (In Russian)

The time rate of neutron moderation to 1.46, 0.3, 0.178, and 0.0976 ev and thermalization time below ~0.1 ev were measured. The distribution time for 0.3 ev neutron moderation in Be and BeO was found. The results obtained were used for calculating corrections of pre-moderation of neutrons at energy range below 1.46 ev and for obtaining the square of the length of fission neutron slowing down to various energies in the thermal range. (tr-auth)

19067 CHARACTERISTICS OF ASYMPTOTIC NEUTRON SPECTRA IN URANIUM. A. A. Malinkin, F. Nasyrov, and V. F. Kolesov. At. Energ. (USSR), 18: 181-3(Feb. 1965). (In Russian)

A spherical critical assembly with (90% enriched) ^{235}U active zone in a 30 cm uranium reflector with a 65 cm cylindrical adjustment, increasing the thickness to 100 cm, was used for measuring ^{235}U and ^{238}U fission cross sections and other spectral characteristics. In addition direct measurements were made of neutron spectra at 0.95 Mev. The equilibrium state of the neutron spectra was determined in relation to the cross sections $\sigma_f(^{235}U)/\sigma_f(^{238}U)$ and $\sigma_f(^{239}Pu)/\sigma_f(^{238}U)$. The cross sections measured by small ionization chambers and by activation methods are tabulated. A helium-filled proportional counter was used for measuring neutron asymptotic spectra in natural uranium. The most probable spectrum energy corresponded to ~50 kev range with mean neutron energy 0.23 ± 0.02 Mev. The data of direct spectrum measurements and measurements by means of spectral characteristics are in good agreement. (R.V.J.)

19068 MODIFIED SPHERICAL HARMONIC METHOD AND NEUTRON TRANSPORT PROBLEM WITH FINITE SPHERICAL CORE. S. J. Wilson and K. K. Sen (Univ. of Singapore). Can. J. Phys., 43: 432-7(Mar. 1965).

The modified double-interval spherical harmonic method developed in earlier papers was applied to the spherical analog of the Milne problem for the half-plane to determine the neutron density as a function of position. The values of the "extrapolated end point" are compared with those obtained by Marshak using the single-interval spherical harmonic method. (auth)

19069 A NEUTRON TUBE WITH CONSTANT OUTPUT (10^{10} n/sec) FOR ACTIVATION ANALYSIS AND REACTOR APPLICATIONS. J. E. Bounden, P. D. Lomer, and J. D. L. H. Wood (Services Electronics Research Lab., Baldock, Herts, Eng.). Nucl. Instr. Methods, 33: 283-8(Mar. 1965).

A compact source of fast neutrons capable of producing well over 10^{10} n/sec was developed. The tube, which uses the D-T reaction consists of an r-f ion source from which a mixture of deuterons and tritons are accelerated onto a loaded erbium target. A life of at least 100 hours was

achieved. The design features which lead to this high output and long life are discussed. The application of the tube to reactor instrumentation and activation analysis is briefly described. (auth)

19070 SLOWING-DOWN SPECTRA IN ZEEP, ZED-2, AND PTR. C. B. Bigham, R. E. Green, and A. Okazaki (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 21: 296-303(Mar. 1965).

The slowing-down spectra in several natural-uranium heavy-water reactor cores and in a ^{235}U light-water reactor were intercompared using activation techniques. The main features of the spectra agree with multigroup diffusion theory calculations, but there are additional effects not included in the theory which can be correlated with uranium resonances. (auth)

19071 NEUTRON SLOWING-DOWN TIMES AND CHEMICAL BINDING IN WATER. Ajoy K. Ghatak and Theodore J. Krieger (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 21: 304-11(Mar. 1965). (BNL-8126)

The thermalization of a pulse of fast neutrons in a large, homogeneous water assembly is investigated numerically. The effect of chemical binding is studied by comparing the results obtained with the free-hydrogen gas and the Nelkin kernels. It is found that chemical binding has an observable effect on some of the quantities of interest in a pulsed-neutron experiment. Two definitions of mean slowing-down time are considered and their relation is examined. Comparisons are made to several experimental measurements and earlier calculations. (auth)

19072 REACTOR NEUTRON-PULSE PROPAGATION. George H. Miley (Univ. of Illinois, Urbana). Nucl. Sci. Eng., 21: 357-68(Mar. 1965).

An asymptotic velocity of $(18.79 \pm 0.32) \times 10^3$ cm/sec is reported for the propagation of a TRIGA reactor neutron pulse through a 4 ft × 4 ft × 5.8 ft graphite thermal column. Interpretation in terms of a proposed theory yields $Dv = (2.34 \pm 0.02) \times 10^5 cm^2/sec$ for 1.60 g/cm^3 graphite. The propagation velocity was found to be independent of reactivity inserted in the range covered by experiment (to 2.90 dollars). Also, the pulse shape was preserved with an amplitude attenuation length equal to that for the steady-state thermal flux. These results are attributed to the fact that the neutron lifetime in the column was shorter than the pulse width and period. Calculations are presented for the reverse situation where the pulse shape is distorted. Pulse measurements with a Boral curtain lowered into the column are used to test the theory for situations in which the slowing-down density is important. (auth)

19073 NEUTRON FLUCTUATIONS IN A REACTOR OF FINITE SIZE. D. R. Harris (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 21: 369-81(Mar. 1965).

Fluctuations of the neutron populations in various phase-space regions in a reactor were examined by development of a three-step analysis. First, the usual transport equation, or an approximation to it, is used to compute the probability that a neutron injected at a certain location in the reactor gives rise to a chain-related descendant neutron in each of a number of differential volume elements in phase space. Second, these conditional probabilities are used to compute product densities, probabilities that nuclear reactions of a certain class are induced in various time intervals by neutrons in each of a number of differential volume elements. Finally, the product densities are used to compute local population moments, parameters arising in the Rossi alpha experiment, auto- and cross-correlation functions, and other quantities of interest in fluctuation studies. The analysis, as applied to various reactor geometries, shows that the usual point-reactor analysis of reactor neutron fluctuations can lead to substantial error in predicting fluctuation magnitudes in startup studies and in determination of some reactor parameters from fluctuation experiments. (auth)

19074 ON THE STOCHASTIC THEORY OF NEUTRON TRANSPORT. George I. Bell (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 21: 390-401(Mar. 1965). (LA-DC-6502)

The probability, $p_n(R,t_f; \underline{x},\underline{v},t)$, is considered that in a multiplying system, a neutron with position $\underline{x}$, velocity $\underline{v}$, at time t leads to exactly n neutrons in region R of $\underline{x},\underline{v}$ space at time t_f. By formulating p_n in terms of first collision probabilities a non-linear (Boltzmann-like) integro-differential equation is derived for the probability generating function, G. The linearized equation for $\mathcal{G} = 1 - G$ is shown to be adjoint to the usual Boltzmann equation for the average neutron flux. The behavior of $\mathcal{G}$ for subcritical and supercritical systems is analyzed. For large t_f-t, it is shown that for subcritical systems $\mathcal{G}$ approaches zero exponentially, while for supercritical systems $\mathcal{G} \rightarrow \mathcal{G}_0$, which is a solution of the time-independent non-linear equation for $\mathcal{G}$ and equals the probability of getting a divergent chain reaction from the initial neutron. One-velocity theory with isotropic scattering is described in some detail, and the extensions are outlined to energy-dependent problems with anisotropic scattering, multiple final states, random sources, counting problems, and delayed neutron precursors. Methods for solution of equations for G are briefly discussed, and it is shown that the asymptotic behavior may be found from solutions of linear time-independent "adjoint α" and "adjoint k" calculations. Derivation of a point model independent of space and velocity is carried out by an expansion in adjoint α eigenfunctions, and the model parameters are shown to differ from those usually assumed in point models. (auth)

19075 THE INFINITE DILUTION RESONANCE INTEGRAL OF THORIUM-232. W. K. Foell (Phillips Petroleum Co., Idaho Falls, Idaho) and T. J. Connolly. Nucl. Sci. Eng., 21: 406-7(Mar. 1965).

The infinitely dilute resonance integral of ^{232}Th was measured and calculated. (D.C.W.)

19076 OSCILLATORY SIGNAL INTERFERENCE WITH THERMAL NEUTRONS IN Si SINGLE CRYSTALS. D. Sippel, K. Kleinstueck, and G. E. R. Schulze (Zentral-institut fur Kernforschung, Rossendorf, Ger. and Technische Universitat, Dresden). Phys. Letters, 14: 174-5(Feb. 1, 1965). (In German)

An experiment was performed to detect the oscillatory inteference effects with thermal neutrons in plane parallel Si single crystals of different thickness. The reflection intensity was measured as a function of the crystal density in symmetrical transmission positions, and the results were found to be in good agreement with the theoretical curve for the integral reflection. (L.B.S.)

19077 COLD NEUTRON SCATTERING BY LIGHT AND HEAVY WATER. H. Teutsch, N. Mateescu, V. Nahorniak, A. Diaconescu, and P. Timis (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 737-49 (1964).

The cold neutron scattering by light and heavy water was studied using the filter technique for the cold neutron beam production and the time of flight method for the scattered neutron spectra analysis. The measurements were performed for light water at room temperature and 88° angle of scattering and for heavy water at room temperature for 45 and 88° scattering angles and at −100°C for 88° scattering angle. The analysis of quasi-elastic scattering, using the models of Vineyard and Singwi-Sjölander, leads to information about the diffusion motion of the molecules. In the range of inelastic scattering were put into evidence several levels ascribed to quantified motions of the molecules. (auth)

19078 SOURCES OF POLARIZED FAST NEUTRONS. N. V. Alekseev, U. R. Arifkhanov, N. A. Vlasov, V. V. Davydov, and L. N. Samoilov. Usp. Fiz. Nauk, 83: 741-52 (Aug. 1964). (In Russian)

A state-of-the-art review devoted primarily to sources of fast polarized neutrons (FPN) of medium energy (up to 35 Mev) is presented. The history of FPN research and some of the problems that can be solved with its aid are briefly reviewed. Along with mentioning various methods for polarization measurements and comparing their advantages and disadvantages, the installation used for this purpose, in which a Hillman solenoid is used to rotate the

nucleon spin through 90° in a magnetic field, is described. Installations of this type can measure simultaneously the polarization of neutrons in a wide spectral range. Another method especially mentioned is the polarization analysis based on electromagnetic (Schwinger) neutron scattering. Various proton-neutron and deuteron-neutron reactions that yield polarized neutrons are analyzed from the point of view of their efficacy as polarized neutron sources. Although the number of reactions investigated so far is small, the production of neutrons with polarization in excess of 20% is now feasible at energies of 0.3–35 Mev, and it is hoped that the T(d,n)^{4}He reaction can be made to produce PFN with higher energies. (ATD)

Nuclear Properties and Reactions

Refer also to abstracts 18093, 18098, 18299, 18300, 18768, and 19067.

19079 (AECL-2163) THE ENERGIES, ANGULAR DISTRIBUTIONS AND YIELDS OF THE PROMPT NEUTRONS FROM INDIVIDUAL FRAGMENTS IN THE THERMAL NEUTRON FISSION OF ^{233}U AND ^{235}U. J. C. D. Milton and J. S. Fraser (Atomic Energy of Canada, Ltd., Chalk River (Ontario)). Mar. 1965. 14p. (SM-60/45). Dep.; $1.00(AECL).

An apparatus for simultaneously recording the velocities of both fission fragments and the velocity of a neutron at any one of 4 angles to the fragment direction was used to investigate the neutron emission properties of individual fragments. Early results for the thermal neutron fission of ^{233}U and ^{235}U exhibit the saw-tooth variation of ν, the neutron yield per fragment, observed in the spontaneous fission of ^{252}Cf. The yields in the vicinity of mass 130 are consistent with no neutrons being emitted from these fragments. Unlike the neutron yields, the average neutron kinetic energy is nearly symmetric about the symmetric mass point, being high near this point and low at the most probable mass division. The paradox between very small yields and high apparent nuclear temperatures was qualitatively explained on the basis of a model which takes account of shell structure in the level densities and assumes that at the time of scission the fragments are cold but, in some cases highly deformed, in others nearly spherical. The model is supported by the fact that in fissions with more than the average total excitation energy, the fragments near mass 130 and 80 receive much less than half of the increase in energy and the other fragment of the pair, much more. (auth)

19080 (ANL-6978) NEARREX, A COMPUTER CODE FOR NUCLEAR REACTION CALCULATIONS. P. A. Moldauer, C. A. Engelbrecht, and G. J. Duffy (Argonne National Lab., Ill.). Dec. 1964. Contract W-31-109-eng-38. 40p. Dep.; $2.00(cy), 1(mn) CFSTI.

NEARREX is a FORTRAN program for computing energy averages of integrated compound nucleus scattering, capture, and fission cross sections. (auth)

19081 (COO-347-16) THE FISSION OF LUTETIUM AT LOW EXCITATION ENERGY (thesis). Herman W. Andre (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). June 1964. Contract AT(11-1)-347. 112p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

The fission of lutetium was studied by bombarding thick targets of highly purified Lu_2O_3 with 39.6-Mev helium ions. The fission products were chemically separated and purified and their activities counted in low-level beta counters. The absolute fission cross sections were calculated by assuming an excitation function based upon the fission of gold at this energy. To insure that the fission products measured did not result from the fission of heavy element impurities, a series of activation experiments were conducted. The principal observations resulting from this study are: the observation of fission in lutetium at low excitation energy; the mass yield curve at an excitation energy of 36.3 Mev is symmetric about mass 89 with a full-width-at-half-maximum of about 17.5 mass units, and an average of one neutron is emitted per fission event; the total fission cross section at 36.3 Mev is about 1.5 ± 0.5 microbarns; and the enhanced fissionability of lutetium compared to other (higher Z) elements is attributed to the significant ground state distortion of the fissioning nucleus as indicated by its large quadrupole moment. Detailed explanations of the experimental procedures and of the chemical separations and purifications are given. (auth)

19082 (CRT-1213) AN APEX PROGRAM FOR FULLY MECHANIZED SHELL-MODEL CALCULATIONS. T. D. Newton (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1965. 41p. (AECL-2223). Dep.; $1.00(AECL).

An outline of a program for mechanical determination of bound states in a shell model of a nucleus is presented. Limitations on magnitudes of soluble problems are stated. The program was written for the G-20 computer in APEX language. (auth)

19083 (GA-5885) NEUTRON CROSS SECTIONS FOR TUNGSTEN ISOTOPES. Topical Report. G. D. Joanou and C. A. Stevens (General Atomic, San Diego, Calif.). Nov. 13, 1964. Contract SNPC-27. 42p. (NASA-CR-54261)

Neutron cross sections for natural W, and W isotopes having mass numbers 182, 183, 184, and 186 are reported. The cross sections are tabulated from experimental values, nuclear-model calculations, and approximations. The results are incorporated into the libraries of the GAM-II and GATHER-II computer programs. (T.F.H.)

19084 (ISS-64/21) IL PROGRAMMA ARIEL PER LO STUDIO DI REAZIONI DI FOTOPRODUZIONE IN IDROGENO. (The ARIEL Program for the Study of Photoproduction Reactions in Hydrogen). G. Farchi and P. Lanciani (Istituto Superiore di Sanita', Rome (Italy). Laboratori di Fisica). June 12, 1964. 80p. Dep.(mn).

A method for studying photoproduction reactions in hydrogen is presented. The input data of the problem are the interval of γ-ray energies and directions and momenta of the charged particles in the final state. With these input data a survey is made of all possible reactions with three charged particles in the final state emitted by γ rays incident on hydrogen and among these are selected the reactions that are comparable with the input data. This survey is performed with a program written in FORTRAN IV language for the IBM 7040 computer. (auth)

19085 (JEN-131-DF/I-42) ESTUDIO DE LA FISION TERNARIA DEL ^{235}U IRRADIADO CON NEUTRONES TERMICOS. (Study of Ternary Fission of ^{235}U Irradiated with Thermal Neutrons). V. Domingo Codoner (Junta de Energia Nuclear, Madrid (Spain). Division de Fisica). 1964. 24p. Dep.(mn).

A total of 1000 fission events in ^{235}U, in which a light particle was emitted, was analyzed. Nuclear emulsions were used. Because of the large number of events analyzed, it was possible to obtain data of good statistical accuracy on the frequency of emission of light particles, on their angular distribution, and the upper limit of their energy spectrum. Also determined were the mean ranges, masses, and energies of the light particles and of the heavy fragments. (auth)

19086 (JEN-143-DF/I-46) ESTUDIO DE LA POLARIZACION PRODUCIDA EN UN HAZ ^{3}He DE 29 Mev POR C, Al, Cu, Sn, Y Au. (The Polarization of a 29-Mev Beam of ^{3}He Particles Scattered by C, Al, Cu, Sn, and Au). José M. Pérez Dominguez (Junta de Energia Nuclear, Madrid (Spain). Division de Fisica). 1964. 16p. Dep.(mn).

A series of ^{3}He polarization measurements were carried out by means of double scattering experiments, in which 29-Mev ^{3}He particles were elastically scattered first from carbon and then from carbon, aluminum, copper, tin or gold. Ilford K1 nuclear plates were used as detector. The most important feature in the carbon polarization is the broad maxima in the interval from 30 to 40°(c.n.). Important asymmetries were also found for aluminum. Small asymmetries were found for copper and tin, in the angular

interval covered by the experiment. Experimental results show only very small asymmetries for gold up to 50° c.m. The experimental results were compared with theoretical calculations of polarization with the optical model. Within the large experimental errors, it was possible to obtain some idea about the order of magnitude of the spin-dependent potential of the optical model. (auth)

19087 (NAA-SR-Memo-9055) PRISM—A FORTRAN CODE FOR THE PREPARATION OF MULTIGROUP INELASTIC AND ELASTIC SCATTERING TRANSFER MATRICES. B. D. O'Reilly, D. W. Roeder, and V. Luco (Atomics International, Canoga Park, Calif.). Sept. 1964. Contract [AT(11-1)-Gen-8]. 50p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Both the theoretical formulation and the use of the FORTRAN code PRISM are presented. PRISM calculates microscopic inelastic and elastic scattering transfer matrices for a given element. For the case of inelastic scattering, the bound energy levels of the target nucleus are treated as discrete when both the levels and their probabilities of excitation as functions of the incident neutron energy are known. When such detailed information is lacking, the calculation is based on the Weisskopf evaporation model. Elastic scattering is treated as the special case of inelastic scattering for which there is a single discrete energy level with zero threshold energy. Several desirable features of PRISM include simplicity of data input, five different spectrum options, and the inclusion of a "catch-bucket" group in the transfer matrices. The results of a sample problem are appended. (auth)

19088 (ORNL-TM-1033) ANGULAR MOMENTUM CALCULATION FROM INTRANUCLEAR CASCADES. H. W. Bertini (Oak Ridge National Lab., Tenn.). Feb. 19, 1965. Contract W-7405-eng-26. 4p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

A code has been written for a simple semiclassical calculation of angular momentum distributions remaining in nuclei following intranuclear cascade reactions. The calculation, and the availability of the code, are discussed. (auth)

19089 (SAL-4) THE RADIATION CORRECTION, A REVIEW OF THE THEORY AND SOME CALCULATED VALUES. Hans Breuer (Saskatchewan Accelerator Lab., Univ. of Saskatchewan, Saskatoon). Dec. 1964. 52p. Dep.(mn).

A review is given of the theory for radiative corrections to the cross sections for elastic and inelastic electron or positron scattering by nuclei. Calculated values are tabulated for scattering in the energy range 20 to 180 Mev. (C.E.S.)

19090 (UCRL-11862) DECAY OF THE Zn^{64*} COMPOUND NUCLEUS FORMED BY NUCLEAR REACTIONS OF p, He^3, He^4, AND C^{12} WITH Cu^{63}, Ni^{61}, Ni^{60}, AND Cr^{52}, RESPECTIVELY (thesis). Charles F. Smith, Jr. (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 1965. Contract W-7405-eng-48. 118p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

An experimental, radiochemical determination of the excitation functions for reactions involving the ^{64*}Zn compound nucleus was performed. The reactant pairs are: p + ^{63}Cu, ^{3}He + ^{61}Ni, ^{4}He + ^{60}Ni, and ^{12}C + ^{52}Cr while the observed products for each such pair are: ^{63}Zn, ^{62}Zn, and ^{62}Cu. Total reaction cross sections are calculated from the optical model. The ratio of the cross section for a given reaction to the total reaction cross section are compared on an excitation energy abscissa for each product. The shape and magnitude of these ratio curves is essentially constant in each such comparison, suggesting a compound nuclear reaction mechanism. Range measurements for ^{62}Zn recoils are made and compared to calculated ranges based on the theory of Lindhard, Scharff, and Schiøtt for a compound nuclear reaction. Good agreement is found. The shapes of these curves are compared to a theoretical estimate obtained from evaporation theory, and are shown to be similar to the calculated shapes. A displacement of the experimental curves relative to one another along the excitation energy axis is noted, and ascribed to angular momentum effects. Using the position of the ^{64}Zn photoexcitation curves of Sagane as reference points, and spin averaged angular momenta of the compound system, the reduced moment of inertia is calculated for the four systems. At least two distinct values are found, indicating a difference between orbital- and spin-angular momenta, the latter causing the greater energy shift in the excitation functions. This observation is shown to be of value in understanding similar energy discrepancies in excitation function comparisons. Because of the observed relation between the mode of formation and the mode of decay of the compound nucleus, it is concluded that the independence postulate is not strictly applicable to this system as a whole. (auth)

19091 (UCRL-11871) NUCLEAR STUDIES USING SEMICONDUCTOR DETECTORS (thesis). Richard Barry Frankel (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 5, 1964. Contract W-7405-eng-48. 159p. Dep.(mn); $5.00(cy), 3(mn) CFSTI.

Germanium surface barrier detectors were used to measure the angular distribution of conversion electrons from the 255-kev isomeric transition in ^{137m}Ce for ^{137m}Ce nuclei aligned in the neodymium ethyl sulfate lattice. Direct comparison with the γ-ray angular distributions gave the particle parameters $(b_2)_k = 1.061(18)$, $(b_2)_L = 1.059(20)$. From the variation of the γ-ray anisotropy with temperature, the hyperfine coupling constant for ^{137m}Ce was determined to be $A = 0.0147(7)$ cm^{-1} using the 1957 temperature scale for this salt. The ^{137m}Ce was also aligned in cerium magnesium nitrate, and the variation of the 255-kev γ-ray anisotropy was studied as a function of temperature. Anomalies were shown to exist in the cerium magnesium nitrate temperature scale derived by Daniels and Robinson A new temperature scale is proposed which goes down to 0.0019°K. To test the new scale, ^{144}Pm was aligned in cerium magnesium nitrate. The anisotropies of the 615- and 695-kev γ-rays were found to be attenuated, but confirmed the ^{137m}Ce results. The decay of ^{137m}Ce + ^{137g}Ce to ^{137}La was investigated with Ge(Li) γ-ray detectors, Si(Li) electron detectors, and nuclear alignment. Levels were found at 10, 446, 492, 708, 762, 781, 835, 925, 1004, and 1170 kev. Definite spin and parity assignments were 762 kev (11/2+), 835 kev (9/2+), and 1004 kev (11/2−). A spin of 5/2+ was tentatively assigned to the 446-kev level. The 11/2− state corresponds to a quasi-particle state predicted by Rho. The distribution of alpha particles from ^{253}Es oriented in neodymium ethyl sulfate was measured using germanium surface barrier detectors. The L = 4 wave in the ground state transition was found to be out of phase with the L = 0 and L = 2 waves. The L = 4 wave was found to have a larger amplitude and the L = 2 wave a smaller amplitude than predictions based on the Bohr, Froman, and Mottleson coupling relations. The relative amplitudes for the ground state transitions are $a_0 = 1$, $a_2 = 0.11$, and $a_4 = 0.016$. (auth)

19092 (UCRL-11875) EFFECTS OF COLLECTIVE EXCITED STATES ON ALPHA PARTICLE BARRIER PENETRABILITY (thesis). Elizabeth A. Rauscher (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 5, 1965. Contract W-7405-eng-48. 50p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

For the alpha decay of ^{212}Po to the ground state and various excited states of the ^{208}Pb daughter, there are collective surface vibrational modes, which couple these low-lying excited states to the ground state of ^{208}Pb. In this description of the transitions between these excited states of ^{208}Pb and the ground state of ^{208}Pb only single phonon excitations are considered. Interaction of the electric multipole nature occurs between the excited state levels and the ground state of the recoil lead daughter induced by its interaction with the emitted alpha particle, affecting the latter's penetration of the nuclear barrier. The formation of the excitation in the lead nucleus can either be produced by ^{212}Po alpha decay or by (α,α') inelastic scattering on ^{208}Pb, but in either case it is considered that an alpha cluster exists in the nuclear surface region. The manner

in which the multipole interaction affects the alpha particle penetration of the nuclear barrier is investigated. (auth)

19093 (UCRL-11902) THE PROMPT GAMMA RAY, PROMPT ELECTRON AND PROMPT X-RAY SPECTRA ASSOCIATED WITH FISSION FRAGMENTS OF SPECIFIC MASS. Harry R. Bowman, Stanley G. Thompson, Rand L. Watson, S. S. Kapoor, and John O. Rasmussen (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 27, 1965. Contract W-7405-eng-48. 27p. (CONF-650301-5). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From Symposium on the Physics and Chemistry of Fission, Salizburg, Austria.

Well-defined prompt gamma rays, prompt-conversion electrons, and prompt K x rays have been observed in coincidence with moving fission fragments of ^{252}Cf. In a few cases, the masses and charges of the nuclei emitting the gamma rays and conversion electrons have been identified. The gamma-ray, prompt-electron and prompt x-ray energies, as well as the two fission fragments' energies, were measured with high-resolution solid-state detectors. The masses of the fragments were deduced from their energies, and the nuclear charges were determined by measuring K x-ray energies associated with different masses. The magnitude and sign of the Doppler shift in gamma energy allowed assignment of the gamma lines to single members of fragment pairs. The Doppler shift also provides an independent measure of the fragment velocity and hence the fragment mass after neutron emission. The results of the x-ray measurements are consistent with the view that the majority of the prompt x rays emitted during the spontaneous fission of ^{252}Cf results from internal conversion during the de-excitation of low-energy collective states of the primary fission fragments. (auth)

19094 (UCRL-12028(p.41-50)) ASTRON PROGRAM. (Lawrence Radiation Lab., Univ. of California, Berkeley and Lawrence Radiation Lab., Univ. of California, Livermore).

Preliminary experiments on electron trapping were conducted, however a sequence of bugs precluded satisfactory operation. Some of the diagnostics equipment failed to operate properly because of noise pickup. As a result, although some electron trapping may have been achieved, there was no good documentation, either of the trapping efficiency or of electron lifetime. Operation was terminated because of mechanical failure, and an extensive modification, including the addition of diagnostics, was started. In the meantime the two new Al (negative flux) coils, were installed in the cantilevers completing the machine. The installation of diagnostic equipment is in progress, and operation resumption is planned. (J.R.D.)

19095 (WASH-1053) REPORTS TO THE AEC NUCLEAR CROSS SECTIONS ADVISORY GROUP, OAK RIDGE NATIONAL LABORATORY, OCTOBER 13-14, 1964. A. B. Smith, comp. (Argonne National Lab., Ill.). Contract [W-31-109-eng-38]. 133p. (EANDC(US)-70"U"; CONF-641010). Dep.; $4.00(cy), 3(mn) CFSTI.

A compilation of reports is presented, containing informal statements of recent developments, changes of emphasis, and preliminary data which are of importance to the AEC cross section measurement program. The reports are not intended to be complete and formal, nor do they represent all of the work related to nuclear cross section measurement being done by the contributors. (J.R.D.)

19096 (ANL-Trans-157) THE SHAPE OF THE FISSIONING NUCLEUS AT THE SADDLE POINT AND THE LIQUID-DROP MODEL OF THE NUCLEUS. V. M. Strutinskii. (Institut Atomnoi Energii im. I. V. Kurchatova, Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Preprint IAE-735. 1964. 7p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.10(fs), $0.80(mf) JCL.

It is shown that the effective moment of inertia of the fissioning nucleus, determined from the angular anisotropy of fission fragments, agrees with the value calculated for the saddle point by means of the liquid-drop model, where the blurring of the edge of the nucleus has been considered. (auth)

19097 ISOTOPE SHIFTS AND HYPERFINE STRUCTURE IN THE ULTRAVIOLET LINES OF CADMIUM. F. Les (Jagellonian Univ., Krakow). Acta Phys. Polon., 26: 951-62(Nov. 1964).

Isotope shifts in the two ultraviolet lines of Cd II (3250 and 3535 Å) for all stable cadmium isotopes were investigated, as well as hyperfine splitting for ^{111}Cd and ^{113}Cd. Enriched cadmium isotopes excited in a Schüler-type hollow cathode discharge tube cooled with liquid nitrogen, and a Fabry-Pérot interferometer with metallic-dielectric mirrors were used for the measurements. The results were generally in accordance within error with those of Kuhn and Ramsden for the line 4416 Å. Moreover, for four even isotopes, the isotope shifts in the resonance line Cd I (3261 Å) were measured. (auth)

19098 ON THE DISINTEGRATION OF ^{7}Li. J. Grabowskii (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Polon., 26: 1255-7(Dec. 1964). (In Russian)

The reaction ^{6}Li + ^{197}Au → ^{197}Au + ^{6*}Li → ^{197}Au + α + d at 60 Mev was studied, taking into account the nuclear interaction of the colliding particles, using the Saxon-Woods potential, as well as the Coulomb interaction. Calculated angular distributions of the alpha particles and deuterons are presented and compared with experimental values. (M.J.T.)

19099 A SIMPLE TREATMENT OF POTENTIAL BARRIER PENETRATION. Bernard L. Cohen (Univ. of Pittsburgh). Am. J. Phys., 33: 97-8(Feb. 1965).

It is pointed out that the penetration of a particle through a potential barrier may be understood as a climb over the barrier during one of the energy fluctuations expected from the uncertainty principle, rather than as a tunneling under the barrier. A method of obtaining the quantitative result with this model is presented. (auth)

19100 A STATISTICAL THEORY OF COMPOUND NUCLEUS FORMATION AND DECAY. Theodore J. Krieger (Brookhaven National Lab., Upton, N. Y.). Ann. Phys. (N. Y.), 31: 88-99(Jan. 1965). (BNL-8019)

The independence of formation and decay of the compound nucleus system in the region of strongly overlapping resonances is investigated within the framework of R-matrix theory. Generalized random sign rules based on the statistical distributions of reduced-width amplitudes and of resonance energies are used. The independence law, as expressed by the factored form of the average partial reaction cross section, is shown to be asymptotically valid to terms of order $(\bar{\Gamma}_{\lambda c}/D)^2$ in the limit $D/\Gamma \to 0$ and N (number of open channels) $\to \infty$. The results are expressed in a form manifestly invariant with respect to transformation of the angular momentum coupling scheme employed in designating the channels. The usual assumption of complete absence of channel-channel correlations is weakened in the case of integrated cross sections to include only the absence of correlations between breakup modes. In case of angular distributions the additional assumption of absence of $\hat{l}$-value correlations is required for independence. The occurrence of an anomalous factor of two in the expression for the fluctuation cross section, as has been noted by Thomas and by Satchler, is verified and a simple approximate scheme for amending the transmission coefficients to include this factor while preserving unitarity is proposed. (auth)

19101 ALPHA DECAY. H. J. Mang (Univ. of California, Berkeley). Ann. Rev. Nucl. Sci., 14: 1-28(1964). (UCRL-11326)

The problem of alpha decay rates and nuclear models is treated. Conservation laws and basic equations are reviewed, and discussions are given of spherical nuclei, the BCS method and alpha decay rates, deformed nuclei, and the decay constant and nuclear surface structure. 79 references. (M.J.T.)

19102 RECENT PROGRESS IN THE THEORY OF NUCLEAR MATTER. A. G. Petschek (Los Alamos Scientific Lab., N. Mex.). Ann. Rev. Nucl. Sci., 14: 29-50(1964). (LADC-6343)

The structure of nuclear matter without Coulomb forces is considered, using many-body and perturbation theories. The origins of the Brueckner-Goldstone theory based on the adiabatic assumption and of a theory based on quantum statistics are described. Velocity dependent potentials and other unusual approaches are dealt with. Approximations to facilitate computation are described. Superfluidity of nuclear matter and finite nuclei are considered. 94 references. (M.J.T.)

19103 NUCLEON, TWO NUCLEON REACTIONS ABOVE 100 Mev. J. Robb Grover (Brookhaven National Lab., Upton, N. Y.) and A. A. Caretto, Jr. Ann. Rev. Nucl. Sci., 14: 51-100(1964). (BNL-8058)

A bibliography to all reported nucleon, two-nucleon cross sections measured by activation above 100 Mev is given. Reaction mechanisms are discussed in terms of transition amplitudes. Contributions from individual reaction mechanisms—clean and unclean knockout, inelastic and charge-exchange scattering, compound nucleus formation, pickup reaction to form a deuteron, and knockout of a deuteron—are considered. Some observations are made on the mechanisms of reactions at energies greater than 400 Mev. 282 references. (M.J.T.)

19104 DYNAMIC ORIENTATION OF NUCLEI. Carson D. Jeffries (Univ. of California, Berkeley). Ann. Rev. Nucl. Sci., 14: 101-34(1964).

A review is given of the methods and processes by which nuclear spins in coupling with electron spins may be appreciably oriented, particularly by the dynamic methods, those involving application of resonant microwave energy to the spin system; special attention is given to polarized proton targets. The development of static and dynamic orientation methods is summarized, and lists are presented of nuclei oriented by these methods. Dynamic microwave methods are reviewed, with discussions of paramagnetic resonance, spin-lattice relaxation, NMR, electron-nuclear dipolar coupling, strong hyperfine coupling, and the Overhauser effect. Other nonstatic methods, using nuclear spin refrigerators, optical pumping, and hot conduction electrons, are mentioned. 248 references. (M.J.T.)

19105 ELECTROMAGNETIC MOMENTS OF EXCITED NUCLEAR STATES. K. Alder (Universitat, Basel and R. M. Steffen. Ann. Rev. Nucl. Sci., 14: 403-82(1964). (TID-20932)

Electric and magnetic multipole moments of nuclear states and electromagnetic transitions are discussed. Interactions of static multipole moments with external fields are considered. Spectroscopic (model-independent) methods of determining electromagnetic moments are described, including spin-precession, Mössbauer, Coulomb-excitation, and optical- and atomic-beam methods. Electromagnetic moments are discussed in relation to nuclear models—the single-particle, shell, core-excitation, rotational, nonaxial-rotator and vibrational, and quasiparticle models. Model-dependent methods of determining electromagnetic moments are reviewed. Tables are given of electromagnetic moments of excited nuclear states. 238 references. (M.J.T.)

19106 CALCULATIONS OF MEAN CROSS SECTIONS IN RADIATIVE CAPTURE OF 10^3 TO 10^5 ev NEUTRONS. A. G. Dovbenko, S. M. Zakharova, V. E. Kolesov, and A. V. Malyshev. At. Energ. (USSR), 18: 114-18(Feb. 1965). (In Russian)

Nuclear statistical theory was used for calculating the mean cross sections in radiative capture of neutrons for thirty isotopes of Rb, Zr, Mo, Sn, and Sm. The calculations were based on the nuclear surface penetrability developed using the optical models and level density corresponding to the Fermi-gas model. The results were correlated with experimental data at 25 kev. It is shown that it is possible to obtain satisfactory estimate of mean cross sections of neutron capture in isotopes with unknown neutron resonance parameters. (tr-auth)

19107 ASYMPTOTIC FORMULAS FOR SLOW NEUTRON SCATTERING ON BOUND ATOMS. V. F. Turchin and V. A. Tarasov. At. Energ. (USSR), 18: 118-21(Feb. 1965). (In Russian)

The Placzek-Wick method was used for developing asymptotic formulas for high energy neutron scattering at mean cosine angles for energy losses and conjugated energy losses. The latter differ from ordinary moments by the conditions of integration which are developed by the initial energy instead of final energy. (tr-auth)

19108 NEUTRON DIFFUSION IN SPIN-ORBITAL INTERACTIONS. Yu. N. Kazachenkov and V. V. Orlov. At. Energ. (USSR), 18: 179-81(Feb. 1965). (In Russian)

The influence of polarization on neutron scattering in a spin-orbital interaction was estimated. The formulas were obtained for the polarization effects on neutron distribution following the second collision. The experimental data presented by B. Lane et al. (Phys. Rev. 126: 1105 (1962)) and variations of the scattering coefficient due to polarization produced the following magnitudes for Si E_n = 0.56 Mev $(\Delta D/D) \approx -0.12$ and for Mg E_n = 0.24 Mev, $(\Delta D/D) \approx -0.17$. (R.V.J.)

19109 EXCITATION FUNCTION OF ^{65}Cu(d,2n)^{65}Zn REACTION AND YIELD OF ^{65}Zn ISOTOPE. P. P. Dmitriev and N. N. Krasnov. At. Energ. (USSR), 18: 184-5(Feb. 1965). (In Russian)

An attempt was made to determine an excitation function for the ^{65}Cu(d,2n)^{65}Zn reaction and to determine the yield of ^{65}Zn at a deuteron energy of 20 Mev. The yield of ^{65}Zn measured by irradiation of a thick copper target at E_d = 20 Mev was 16 ± 2μC/μg. The yield of ^{65}Zn was also studied with a stack of 32 (15.5 mg/cm thick) copper foils irradiated in a cyclotron at a deuteron energy of 21 Mev and 3μamp current. The yield of ^{65}Zn as a function of deuteron energy (to E_d = 21 Mev) was obtained by graphical integration of the excitation function. The yield at E_d = 20 Mev was equal to 16μC/μamp. hr which coincided with the magnitude obtained with the thick target. (R.V.J.)

19110 ELECTRIC DIPOLE PHOTON ABSORPTION IN ^{32}S. B. M. Spicer (Univ. of Virginia, Charlottesville). Australian J. Phys., 18: 1-6(Feb. 1965).

The particle-hole model was applied to the calculation of E1 photon absorption by ^{32}S. A plausible unperturbed spectrum was obtained from investigation of the results of the ^{32}S(d,p)^{33}S and ^{32}S(p,2p)^{31}P reactions. The results of the calculation are compared with experiment, and suggestions are made with reference to the shortcomings of the calculation. (auth)

19111 PARAMETERS OF TWO LEVELS OF THE ^{17}F NUCLEUS. W. Toutenhoofd (Univ. of Melbourne). Australian J. Phys., 18: 7-13(Feb. 1965).

The resonance structures in the ^{16}O(p,p)^{16}O excitation curve at energies of 10.52 and 12.40, as found by a University of Wisconsin group, were analyzed. Spin and parity for the levels of ^{17}F at 10.50 and 12.26 Mev are believed to be $\frac{7}{2}^-$ and $\frac{3}{2}^-$, respectively. (auth)

19112 THE PHOTONUCLEAR GIANT RESONANCE IN SILICON-28. A. W. Parker, R. R. Whitehead, and G. G. Shute (Univ. of Melbourne). Australian J. Phys., 18: 15-21 (Feb. 1965).

The 90° yields of gamma rays from the reaction ^{27}Al(p,γ)^{28}Si were obtained at intervals of 40 kev for proton energies between 8.02 and 10.42 Mev. The ground state x-ray (γ_0) and the first excited state γ ray (γ_1) were adequately resolved. The two yield curves show considerable structure; and, with the present resolution, there is a strong one-way correspondence between them. The gross structure of the γ_0 yield curve is compared with data from the ^{28}Si(γ,n)^{27}Si reaction, and fair agreement is found. (auth)

19113 INELASTIC ELECTRON SCATTERING AND MAGNETIC PROPERTIES OF NUCLEONS BOUND IN NUCLEI. W. Czyz (Inst. of Nuclear Physics, Krakow). Bull. Acad. Polon. Sci., Ser. Sci. Math. Astron. Phys., 12: 649-53(1964).

A sum rule is discussed by which the magnetic properties of bound nucleons can be investigated by electron inelastic scattering. (D.C.W.)

19114 STUDIES IN THE ACTIVE DEPOSIT OF ACTINIUM. PART II. THE DECAY OF ^{211}Pb(AcB). C. R. Cothern and R. D. Connor (Univ. of Manitoba, Winnipeg). Can. J. Phys., 43: 383-403(Mar. 1965).

Studies of the active deposit of actinium using a Siegbahn-Slatis beta-ray spectrometer and scintillation counters together with gamma-gamma coincidence work and gamma-gamma angular correlation measurements have led to the establishment of a new decay scheme for ^{211}Pb and a level scheme for ^{211}Bi involving five excited states. Fermi analysis yields 1.378 Mev as the highest end-point energy of the beta partial spectra. Angular correlation studies of the 430–400- and 706–400-kev gamma-ray cascades yielded spins for the levels concerned: ground level ($^9/_2$), 400-kev level ($^7/_2$), 830-kev level ($^9/_2$), and 1,100-kev level ($^7/_2$). These spins are the only ones consistent with the experimental evidence and the theoretical arguments presented. (auth)

19115 DELAYED PROTONS FOLLOWING THE DECAY OF ARGON-33. J. C. Hardy and R. I. Verrall (McGill Univ., Montreal). Can. J. Phys., 43: 418-21(Mar. 1965).

The delayed-proton precursor ^{33}Ar was produced by proton bombardment of a lithium chloride target in the internal beam of the McGill synchrocyclotron. The half life of ^{33}Ar was measured to be (178 ± 10) msec. To explain the delayed proton spectrum, two new levels, at 5.55 and 7.55 Mev, in ^{33}Cl are proposed. It is also proposed that the former is the expected first T = $^3/_2$ state in that nucleus. (auth)

19116 NEUTRON CROSS SECTION OF SILICON FROM 500 TO 1200 kev. Jean Cabe, Michel Laurat, and Pierre Yvon. Compt. Rend., 259: 4616-19(Dec. 21, 1964). (In French)

The utilization of the beam of a 2-Mev Van de Graaff made possible the measurement of the total cross section of silicon from 500 to 1200 kev. The very good energy resolution of the apparatus used (ΔE_n = 3 kev) showed a new level near 804 kev. The Breit-Wigner formula applied to the experimental results gives J = ($^3/_2$)I ≥1. (tr-auth)

19117 MEASUREMENT OF THE CROSS SECTION OF COPPER-63 FOR THE (n,2n) REACTION PRODUCED BY 14.1-Mev NEUTRONS. Jean Letessier and Jean Dalmas (Universite, Bordeaux). Compt. Rend., 259: 4620-3 (Dec. 21, 1964). (In French)

The determination of the cross section of the reaction ^{63}Cu(n,2n)^{62}Cu at 14.1 Mev was made by activation. The value found is 478 ± 48 mb. The neutron flux was measured by using a long counter. (tr-auth)

19118 APPLICATION OF THE PHENOMENOLOGICAL ROTATIONAL MODEL TO THE LITHIUM-6 NUCLEUS. Daniel Gogny and Maurice Jean (Commissariat a l'Energie Atomique, Orsay, France). Compt. Rend., 260: 510-12 (Jan. 11, 1965). (In French)

The application of the rotational model to ^{6}Li made it possible to take into consideration in a satisfactory manner some low-energy properties of this nucleus: level scheme, quadrupole moment, magnetic moment, and β decay. (tr-auth)

19119 ON CALCULATION OF THE EVAPORATION SPECTRA OF CHARGED PARTICLES. Rui da Silveira (Facultes des Sciences de Paris, Orsay, France). Compt. Rend., 260: 513-16(Jan. 11, 1965). (In French)

The experimental spectra of the evaporation of α particles were compared to the distributions calculated by the statistical model. It is shown that the emission of charged particles with energy much below the Coulomb barrier can be obtained correctly if a convenient approximation is taken for the cross section of the inverse process. (tr-auth)

19120 STUDY OF ^{16}O(d,p_1) AND ^{11}B(d,p_0) REACTIONS AT LOW ENERGY (300 kev). Nicole Longequeue, Henri Beaumevieille, Jean-Pierre Longequeue, Michel Sandon, and Emile Ligeon (Universite, Grenoble, France and CEN, Grenoble, France). Compt Rend., 260: 517-19(Jan. 11, 1965). (In French)

The angular distributions of the reactions ^{16}O(d,p_1) and ^{11}B(d,p_0) at energies of the order of 300 kev show a sharp rise for forward angles. An attempt at interpretation of the angular distributions of ^{16}O(d,p_1) was made using the Coulomb theory of stripping and is in good agreement with experimental results. (tr-auth)

19121 ABSORPTION CROSS-SECTIONS FOR THE NUCLEAR SCATTERING OF HIGH ENERGY NUCLEONS BY CARBON. R. H. N. Iyer and G. Z. Shah (Bhavan's Coll., Bombay). Current Sci. (India), 33: 643(Nov. 5, 1964).

The absorption cross sections for carbon were calculated for several energies between 300 and 970 Mev. The results were compared with experimental values. The calculated values were within the experimental errors up to 650 Mev, beyond which the agreement was approximate. (D.C.W.)

19122 SYSTEMATICS OF 5$^-$ LEVELS OF EVEN-EVEN NUCLEI. S. Swarnagowri and M. K. Ramaswamy (Karnatak Univ., Dharwar, India). Current Sci. (India), 33: 678 (Nov. 20, 1964).

The log ft values of allowed beta transitions to 5$^-$ levels of even-even nuclei were considered. No evidence for either enhancement or hindrance was observed. (D.C.W.)

19123 DECAY OF Ba^{131} AND LEVELS IN Cs^{131}. Tachishige Hirose and Takashi Miyaji (Tokyo Inst. of Tech.). Genshikaku Kenkyu, 9: 172-202(June 1964). (In Japanese)

The decay of 11.5-day ^{131}Ba was studied with a beta spectrometer and NaI scintillation spectrometers. The radioactive source was produced by the reaction ^{131}Cs(p,3n)^{131}Ba. Twenty transitions in ^{133}Cs were observed in the internal conversion spectrum. The decay scheme previously proposed is confirmed. The multipolarities of 10 transitions are determined with K/L ratios and K-conversion coefficients. The gamma-gamma angular correlation experiment was performed for the 924–124 kev cascade in ^{131}Cs. The observed correlation function was $W(\theta) = 1 + (0.0012 \pm 0.016)\ P_2(\cos\theta) + (0.011 \pm 0.029)\ P_4(\cos\theta)$. The spins and parities of excited states of ^{131}Cs are assigned from the multipolarities and the angular correlation function. The observed energy levels and the spins and parities in ^{131}Cs are: 79($^7/_2^+$, $^5/_2^+$, $^3/_2^+$), 124($^3/_2^+$, $^1/_2^+$, $^5/_2^+$), 134($^5/_2^+$, $^1/_2^+$, $^3/_2^+$), 216($^3/_2^+$), 373($^3/_2^+$), 585($^1/_2^+$, $^3/_2^+$), 670($^1/_2^+$, $^3/_2^+$), 697 ($^1/_2^+$, $^3/_2^+$), 1048 kev ($^3/_2^+$, $^1/_2^+$), where spins and parities are shown in parentheses. The results are in good agreement with those of Kelly et al. and Horen et al. (auth)

19124 A DISCUSSION OF THE APPROXIMATE NATURE OF THE EXPONENTIAL DECAY LAW AS APPLIED TO RADIOACTIVE NUCLIDES AND GAMMA RAY ABSORPTION. Herbert L. Jackson (Univ. of Iowa, Iowa City). Health Phys., 11: 179-83(Mar. 1965).

The probability of the total decay of a quantity of radioactive material in a finite period of time is discussed, appropriate formulas derived, and examples are given. (auth)

19125 RADIOACTIVE DECAY OF COBALT-58. V. V. G. Sastry, V. Lakshminarayana, and Swami Jnananda (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 3: 67-8(Feb. 1965).

The radioactive decay of ^{58}Co was studied employing a 4π-geometry sum peak coincidence scintillation spectrometer with a view to estimating the fractional intensities for the crossover and the cascade for the decay of the 1620-kev level. These fractional intensities estimated to be 15 and 85 percent respectively, lend support to the level scheme for ^{58}Fe suggested by Frauenfelder et al. (auth)

19126 ON THE MOMENT OF INERTIA IN THE EXCITED SUPERFLUID NUCLEI. R. Kh. Safarov and L. Sh. Khodzhaev (Inst. of Nuclear Physics, Uzbek SSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 54-8 (1964). (In Russian)

The method used previously for deriving a formula for the moment of inertia of an even-even nucleus with account of the pair correlations of superconducting type in the adiabatic approximation of perturbation theory, is extended to include excited nuclei, where account must be taken of the blocking effect that manifests itself in the change of the superfluid properties of the nucleus on going from the ground state to the excited state. The superfluid model

used by V. G. Solov'yev is employed. The fundamental equations of the superfluid model were determined with the aid of the variational principle of N. N. Bogolyubov. It is pointed out that the formula obtained for the moment of inertia of the excited nucleus differs from that derived by Yuan Liu and it is suggested that the results of the latter for the nuclei ^{172}Yb and ^{182}W be carefully reviewed. (ATD)

19127 PROBABILITY OF ELECTROMAGNETIC TRANSITIONS BETWEEN EXCITED STATES OF ODD NUCLEI WITH SMALL NON-AXIALITY. Sh. Sharipov (Inst. of Nuclear Physics, Uzbek SSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 59-62(1964). (In Russian)

The reduced probabilities of electromagnetic transitions between the states within the ground (n = 0) rotational-single-particle band, with account of the contribution of an external nucleon are calculated. It is pointed out that similar probabilities were previously calculated for odd nuclei with negative intrinsic quadrupole moment, in which there was no need for taking into account the contribution of the external nucleon, since the latter was a neutron and made a negligible contribution to E2 transitions. The reduced probability is calculated in the form of three components: collective, single-particle, and correlation. Tables are presented of the numerical values of the coefficients of the wave functions and of the calculated reduced probabilities of E2 and M1 transitions, with a separate listing for the contribution of the correlation term to the E2 transitions. (ATD)

19128 FINE STRUCTURE IN THE ENERGY DISTRIBUTION OF PROTONS IN THE REACTION $Al^{27}(\gamma,p)Mg^{26}$. T. Dragnev and M. Delchev. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 10: 47-51(1962). (In Russian)

A detailed study, with higher statistics and precision of determination of the energy of protons, was made of the energy and angle distribution of protons from the reaction $^{27}Al(\gamma,p)^{26}Mg$ at a maximum gamma energy of 60 Mev. A fine structure is observed in the energy distribution based on about 8,500 traces. The angular distributions of all protons, as well as of the separating groups of protons are isotropic. The good coordination of the general progress of the obtained energy distribution with that obtained by Cameron and Hoffman, at a maximum photon energy of 25 Mev, as well as the angular distributions of all protons in the two works show that the majority of protons with energies of up to 15 Mev are obtained from photons with energies of up to 25 Mev. (auth)

19129 ABOUT THE MOMENT OF EMISSION OF PROMPT NEUTRONS IN THE FISSION OF HEAVY NUCLEI. T. Dragnev, N. Kashoukeev, N. Pancheva, and N. Yaneva. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 10: 53-6(1962). (In Russian)

A method is proposed for determining the moment of emission of prompt neutrons in the fission of heavy nuclei. The comparison between theoretically calculated and experimentally obtained energy distributions of neutrons at different angles to the direction of fission, registered at a fixed ultimate velocity of the fragments, makes it possible to find the velocity of the fragments at the moment of the emission of neutrons. The time of the emission of neutrons is determined in accordance with the law of the motion of fragments. (auth)

19130 YIELDS AND CROSS-SECTIONS OF THE REACTION $Ca^{40}(\gamma,p)K^{39}$ IN THE ENERGY REGIME OF GIANT RESONANCE. T. Dragnev. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 12: 93-100(1964). (In Russian)

The yields for the $^{40}Ca(\gamma,p)^{39}K$ reaction at 16, 19, 22, 25, and 28 Mev were determined from measurements of the proton angular and energy distributions. The cross sections of the reaction for gamma energies from 16 to 28 Mev were also determined. The maximum cross section was found at a gamma energy of 19.3 Mev. (D.C.W.)

19131 MOMENTUM DISTRIBUTION OF NEUTRINOS OBTAINED BY TARGET IRRADIATION WITH NUCLEONS OR NUCLEI. Chr. Christov and D. Fakirov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 12: 231-6(1964). (In Russian)

The momentum distribution of neutrinos produced by irradiation of a nuclear target with nucleons or nuclei of fixed momentum is calculated. (D.C.W.)

19132 SPACE AND MOMENTUM DISTRIBUTION OF NEUTRINOS OBTAINED BY TARGET IRRADIATION WITH NUCLEONS AND NUCLEI. Hr. Hristov and D. Fakirov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 12: 237-43(1964). (In Russian)

The momentum and space distributions of neutrinos from the decay of mesons (π) produced in target irradiation with high-energy particles is calculated. It is assumed that the mesons (π) are produced and scattered according to the mechanism proposed by Landau for multiple production in high-energy particle collisions. (D.C.W.)

19133 HEAVY MASS YIELDS IN THE SLOW NEUTRON FISSION OF ^{233}U AND ^{235}U. L. R. Bunney and E. M. Scadden (Naval Radiological Defense Lab., San Francisco). J. Inorg. Nucl. Chem., 27: 273-9(Feb. 1965).

The chain yields of masses 157, 159, and 161 in the thermal neutron fission of ^{233}U were determined by radiochemical methods. The last radioactive member of the mass chain was isolated and its activity measured relative to ^{99}Mo. With this ratio and pertinent data from the thermal neutron fission of ^{235}U, the mass chain yield was calculated. The chain yields are as follows: mass 157 (15.4 hr ^{157}Eu), 6.4×10^{-3}%; mass 159 (18.5 hr ^{159}Gd), 9.1×10^{-4}%; and mass 161 (6.9 day ^{161}Tb), 1.2×10^{-4}%. These yields were higher than were to be expected from analogy with the relative yields from thermal neutron fission of ^{235}U. A possible explanation is given. The chain yields of masses 91, 141, 143, 144, 147, 149, 151, and 153 in the thermal neutron fission of ^{233}U and ^{235}U were also determined in the same manner as above. The values, when compared to the literature values for the chain yields, provided an estimate of the accuracy of the radiochemical measurement. The accuracy was estimated to be ±10%. Improved values were obtained for the chain yields of mass 156 in the thermal neutron fission of ^{233}U and of mass 157, 159, and 161 in the thermal neutron fission of ^{235}U. (auth)

19134 THE ^{44}Ti HALF-LIFE. P. E. Moreland, Jr. (Argonne National Lab., Ill.) and D. Heymann. J. Inorg. Nucl. Chem., 27: 493-6(Mar. 1965).

The half life of ^{44}Ti was determined by combining an isotopic dilution measurement of the amount of ^{44}Ti in a sample with γ counting of the short-lived ^{44}Sc daughter in equilibrium. A half life of 48.2 ± 0.9 years was obtained. (auth)

19135 YIELDS OF ZIRCONIUM ISOTOPES FROM SPONTANEOUS AND 14.7-Mev NEUTRON-INDUCED FISSION OF URANIUM-238. Tin Mo and P. K. Kuroda (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 27: 503-8(Mar. 1965).

Measurements of the $^{95}Zr/^{238}U$ equilibrium ratios in non-irradiated uranium salts gave the following results: $(3.7 \pm 0.8) \times 10^{-4}$ and $(4.9 \pm 1.0) \times 10^{-4}$ disintegrations per second of ^{95}Zr per gram of ^{238}U in depleted and natural uranium, respectively. If it was assumed that the ^{95}Zr activity in depleted uranium is produced solely by spontaneous fission of ^{238}U, and if Segre's value of 8.0×10^{15} years for the spontaneous fission half life of ^{238}U was taken to be correct, the ^{238}U spontaneous fission yield for ^{95}Zr was calculated to be (5.3 ± 1.1)%. Yields of ^{95}Zr, ^{97}Zr, and ^{99}Mo from 14.7-Mev neutron-induced fission of ^{238}U were found to be 6.1 ± 0.6, 4.7 ± 0.5; and 5.7 ± 0.5%, respectively. (auth)

19136 NOTE ON ELECTRON SCATTERING AND THE IONIZATION CORRECTION. H. Breuer (Univ. of Saskatchewan, Saskatoon, Can.). Nucl. Instr. Methods, 33: 226-8 (Mar. 1965).

The ionization correction for the cross section of elastic and inelastic electron scattering is calculated on the basis of the theory of Blunck and Leisegang instead of the usual Landau theory. The region of validity is discussed. An example (Au, 100 Mev, ΔE = 0.2 Mev, 1% radiation length)

shows, that the new ionization correction leads to 5% larger values. (auth)

19137 THE $V^{51}(p,n)Cr^{51}$ REACTION AS A NEUTRON SOURCE OF KNOWN INTENSITY. K. K. Harris, H. A. Grench, R. G. Johnson, and F. J. Vaughn (Lockheed Missiles and Space Co., Palo Alto, Calif.). Nucl. Instr. Methods, 33: 257-60(Mar. 1965).

The characteristics of the $^{51}V(p,n)^{51}Cr$ reaction and its use as a neutron source of known intensity are discussed. Experimental techniques for the preparation and use of vanadium targets are described. Data on the neutron yield from the $^{51}V(p,n)^{51}Cr$ reaction are presented for proton energies in the range from 1.58 to 2.28 Mev. (auth)

19138 THE REACTION $B^{11}(p,\gamma)C^{12}$, AT THE 163 kev RESONANCE AS A SOURCE OF 11.7 AND 16.1 Mev GAMMA RAYS. F. Cvelbar, A. Hudoklin, and M. Potokar (Nuclear Inst. "Jozef Stefan," Ljubljana, Yugoslavia). Nucl. Instr. Methods, 33: 349-50(Mar. 1965).

The 163-kev proton resonance of the reaction $^{11}B(p,\gamma)^{12}C$ can be used as a source of 11.7- and 16.1-Mev gamma rays for the calibration of various spectrometers. A source of 11.7-Mev radiation of the intensity of a few μC can be obtained. The values of the intensity ratio of 16.1- to 11.7-Mev gamma rays were measured with a scintillation pair spectrometer. (C.E.S.)

19139 PREPARATION OF THIN SILICON TARGETS BY REDUCTIVE EVAPORATION. I. Berecz, J. Karolyi, and A. Szalay (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Instr. Methods, 33: 364(Mar. 1965).

A technique was developed by which SiO_2 is entirely reduced to elementary Si and the Si vapor emerges within a narrow angle from a Ta tube and is condensed on a backing with an efficiency of nearly 100%. The reduction and evaporation was carried out by electron bombardment heating in high vacuum. (C.E.S.)

19140 ENERGY LEVELS IN EVEN TIN ISOTOPES FROM 11 Mev PROTON INELASTIC SCATTERING. D. L. Allan, B. H. Armitage, and Beryl A. Doran (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 66: 481-93(May 1965).

Energy levels in the closed proton shell, even-mass Sn nuclei from ^{116}Sn to ^{124}Sn were excited by 11-Mev proton inelastic scattering. A high resolution study of the scattered proton groups revealed many new levels with excitation energies up to 4 Mev, in addition to the levels first observed in radioactive decay. Strong groups corresponding to the 2^+ and 3^- collective levels found by Cohen and his co-workers were also observed. Some additional evidence for the existence of a 0^+, 2^+, 4^+ triplet of levels in this region is presented. (auth)

19141 EFFECTIVE NUMBERS OF NUCLEON CLUSTERS IN LIGHT NUCLEI DETERMINED FROM QUASI-ELASTIC KNOCK-OUT REACTIONS. P. Beregi (Moscow State Univ.), N. S. Zelenskaya, V. N. Neudatchin, and Yu. F. Smirnov. Nucl. Phys., 66: 513-30(May 1965).

The effective number $N_{eff}(X)$ of nucleon clusters of type X, occurring in high-energy quasi-elastic scattering reactions is calculated in the oscillator shell model with elimination of the c.m. motion. One finds $N_{eff}(d) = {}^{113}/_{18}$, ${}^{34}/_{9}$, ${}^{33}/_{2}$; $N_{eff}(t) = {}^{53}/_{9}$, ${}^{106}/_{9}$, ${}^{184}/_{5}$; $N_{eff}(\alpha) = {}^{103}/_{32}$, ${}^{231}/_{32}$, ${}^{437}/_{32}$ for the target nuclei ^6Be, ^{12}C, and ^{16}O, respectively. The distribution of $N_{eff}(\alpha)$ shows concentration towards the surface. One finds $N_{eff}(^6Li, ^7Li, ^8Li, ^8Be) = 0.09, 0.13, 0.005, 0.3$ for ^{16}O. The integral momentum distributions are calculated for the knock-out of α particles from ^{12}C. The results of these calculations are compared with available experimental data. A comparison of the shell model, cluster model, and α model approaches is outlined on the basis of the example of the deuteron knock-out from ^6Li. A method for calculating the fractional parentage coefficients $\langle A|A-X,X\rangle$ in the translational invariant oscillator shell model is considered. (auth)

19142 THE (p,pα) AND (α,2α) REACTIONS AT MEDIUM ENERGY. Y. Sakamoto (National Research Council, Ottawa). Nucl. Phys., 66: 531-44(May 1965).

A formalism is presented for (p,pα) and (α,2α) reactions for incident particles of medium energy. The (α,2α) reaction is very similar to the (p,pα) reaction. Both reactions are treated in terms of the momentum distribution of the center-of-mass of the alpha-particle cluster and of the extent of alpha-particle clustering of nucleons inside the nucleus. The interactions between the incident particles and the alpha-particle cluster inside the nucleus are determined from free p-α and α-α scattering. The wave function of the alpha-particle cluster is constructed from single-particle harmonic-oscillator wave functions for the nucleons in the nucleus. As examples the $^{12}C(p,p\alpha)$ and $^9Be(\alpha,2\alpha)$ reactions are studied by using this wave function. (auth)

19143 ANGULAR CORRELATION MEASUREMENTS IN ^{99}Tc. P. Da R. Andrade, Alice Maciel, C. S. Mueller, J. Wirth, and F. C. Zawislak (Universidade do Rio Grande do Sul Porto Alegre, Brazil). Nucl. Phys., 66: 545-52 (May 1965).

The delayed angular correlation of the ^{99}Tc 741-181 kev gamma-gamma cascade was measured in a liquid molybdenum source and no attenuation of the $A_{2k}(t)$ coefficients was observed; $A_2 = +0.125 \pm 0.005$ and $A_4 = -0.010 \pm 0.008$. A determination of the half life of the 181-kev level was made and the value obtained is in good agreement with earlier results, $T_{\frac{1}{2}} = 3.59 \pm 0.05$ nsec. Using the integral angular correlation method with an external magnetic field, the g factor of the 181-kev level was measured to be $g = +1.44 \pm 0.12$. (auth)

19144 ENERGY LEVELS OF O^{16} IN THE VICINITY OF 13 Mev. [PART] II. I. V. Mitchell and T. R. Ophel (Australian National Univ., Canberra). Nucl. Phys., 66: 553-61 (May 1965).

Angular distribution data of the $^{12}C(\alpha,\alpha')$ reaction were obtained for incident bombarding energies of between 7.7 and 8.4 Mev. In addition, some measurements were made of the $^{12}C(\alpha,p_0)$ and $^{12}C(\alpha,\gamma\gamma)$ reactions within the same energy range. The results, when analyzed in conjunction with other recent measurements, demonstrate the existence of several levels in ^{16}O at about 13 Mev excitation. (auth)

19145 THE ENERGY LEVELS OF Co^{56}. D. O. Wells (Univ. of Oregon, Eugene). Nucl. Phys., 66: 562-76(May 1965).

Energy levels of ^{56}Co were calculated using Yukawa and finite-angular forms for the residual proton-neutron interaction. The shell-model $(1f_{\frac{7}{2}}^{-1}, 2p_{\frac{3}{2}})$ configuration was assigned to the ground (4^+), 0.164-Mev (3^+), and 0.984-Mev (2^+) levels. The $(1f_{\frac{7}{2}}^{-1}, 1f_{\frac{5}{2}})$ configuration was assigned to the 1.47-Mev (2^+) and 1.74-Mev (1^+) levels. It was predicted that the level at 0.560 Mev is predominantly $(1f_{\frac{7}{2}}^{-1}, 2p_{\frac{3}{2}})_{5+}$, and that those at 0.825, 1.008, and 1.105 Mev are $(1f_{\frac{7}{2}}^{-1}, 1f_{\frac{5}{2}})_{5+}$, $(1f_{\frac{7}{2}}^{-1}, 1f_{\frac{5}{2}})_{3+}$, and $(1f_{\frac{7}{2}}^{-1}, 1f_{\frac{5}{2}})_{4+}$, respectively. (auth)

19146 PHOTOPRODUCTION OF CHARGED PIONS FROM NUCLEI. [PART] III. G. Ramachandran (MATSCIENCE, Inst. of Mathematical Sciences, Madras) and V. Devanathan. Nucl. Phys., 66: 595-608(May 1965).

Compact expressions for the cross section for photoproduction of pions from complex nuclei with a configuration of closed shells plus equivalent nucleons are obtained in impulse approximation considering all types of angular momentum coupling between the nucleons. These formulas enable numerical calculation for nuclei with any number of equivalent nucleons once certain single-particle transition probabilities in the corresponding shell are calculated; these probabilities are tabulated for some particular cases. The amplitudes of Chew et al. which are found valid up to 500 Mev are used for numerical calculations for the ^{60}Ni $(\gamma,\pi^-)^{60}Cu$ reaction. Comparison with available experimental data indicates a definite preference to square well functions over the oscillator functions in the 2p shell. (auth)

19147 THE PROBABILITY FOR TRANSITIONS BETWEEN THE FIRST 2^+ AND THE FIRST 0^+ EXCITED STATES OF O^{16}. H. Fuchs, K. Hagemann, and C. Gaarde (Universitet, Copenhagen). Nucl. Phys., 66: 638-40 (May 1965).

The probability for γ-transitions from the 6.92-Mev 2^+ state in ^{16}O to the 6.06-Mev 0^+ state was measured relative to the probability for ground-state transitions. The branching ratio obtained is $R = (2.7 \pm 0.7) \times 10^{-4}$, in agreement with an earlier result. (auth)

19148 INTERACTIONS OF 17 Gev/c NEGATIVE PIONS WITH HEAVY NUCLEI IN EMULSION EXPOSED IN A STRONG MAGNETIC FIELD. L. Hoffmann, (CERN, Geneva), N. K. Rao, M. A. Shaukat, E. Villar, P Zielinski, E. Cieslak, P. Ciok, T. Saniewska, and E. Skrzypczak. Nucl. Phys., 66: 657-68(May 1965).

In an emulsion stack irradiated by a beam of 17-Bev/c negative pions in the presence of a 165 kOe magnetic field, 234 stars with $N_h > 8$ were analyzed. The stars correspond to the interactions of primary pions with Ag and Br nuclei, characterized by large energy transfers to the target nuclei. The statistical results concerning the momentum, transverse momentum and angular distributions are given separately for the positive and negative secondary particles. The partition of the primary energy between the different types of secondary particles was considered. The differences in the features for the positive and negative secondary particles are discussed. A comparison with 24-Bev/c proton interactions was carried out. (auth)

19149 RADIATIVE CAPTURE OF STOPPED NEGATIVE PIONS BY NUCLEI. V. I. Petrukhin and Yu. D. Prokoshkin (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., 66: 669-72(May 1965).

Experiments aiming at the radiative capture of stopped π^- mesons by nuclei are described. The probability of the process detected is 2×10^{-2} and depends weakly upon nuclear charge and mass. The energy spectrum of γ quanta emitted in the capture turned out to be hard. The mean γ energy was about 80 Mev. (auth)

19150 MEASUREMENT OF THE HALF-LIFE OF U^{235} FOR ALPHA EMISSION. A. J. Deruytter, I. G. Schroeder, and J. A. Moore (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 21: 325-8 (Mar. 1965).

A more precise value of the half life of ^{235}U, for alpha emission, was determined from an analysis of the alpha spectrum of natural uranium. The alpha spectrum was measured using solid-state detectors, and the half life was obtained by a comparison of the intensity of the resolved portion of the ^{235}U alpha spectrum with the intensities of the ^{234}U and ^{238}U alpha groups. The value obtained was $6.92 \pm 0.09 \times 10^8$ yr. (auth)

19151 THE COULOMB FIELD IN $\Sigma\pi$ PRODUCTION BY SLOW K^- MESONS IN COMPLEX NUCLEI. M. Friedmann, D. Kessler, A. Levy, and A. Perlmutter (Soreq Research Establishment, Yavne, Israel). Nuovo Cimento (10), 35: 355-76(Jan. 16, 1965). (1A-948)

The $\Sigma\pi$ production by mesons (K^-) at rest in complex nuclei is analyzed with the help of a Monte-Carlo model based upon peripheral K^- absorption, impulse approximation, and isotropic emission. The $\Sigma^-\pi^+$ and $\Sigma^+\pi^-$ events are considered separately. It is shown that the gross features of these interactions are dominated by the deflection of the outgoing charged particles in the Coulomb field of the recoil nucleus. Specifically, the Σ^-/Σ^+ ratio in nuclear emulsion, the momentum spectra, and invariant mass spectra of the $\Sigma\pi$ system, and angular correlations are discussed. Comparison with experimental data confirms the basic assumptions underlying the model. (auth)

19152 NUCLEON CORRELATION AND THE NUCLEAR PHOTO-EFFECT. R. Malvano and G. Ricco (Universita, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cimento (10), 35: 484-91(Jan. 16, 1965).

A systematic investigation was performed in light mirror nuclei using the elastic electron scattering and γ absorption cross section data to evaluate the space correlation between nucleons. The results were compared with the theoretical predictions of various nuclear models. (auth)

19153 THE PROJECTORS AND THE THEORY OF RESONANCES IN NUCLEAR REACTIONS. M. Coz (Universite de Paris, Orsay, France). Nuovo Cimento (10), 35: 492-509(Jan. 16, 1965). (In French)

A method is constructed to separate out resonances using projectors. The method takes into account the bound states imbedded in the continuum (Fonda, Newton) as well as the bound states in the closed channels (Feshbach). The starting point is Feshbach's unified theory. With the condition that the resonant part of the transition amplitude is a sum of Breit-Wigner terms one obtains the dissociation of the effects of these two kinds of resonances. The method is discussed as an exact theory of all resonances. (auth)

19154 SCALAR MESONS AND THE NUCLEAR SPIN-ORBIT COUPLING. A. Bietti and B. Touschek (Universita, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 35: 582-5(Jan. 16, 1965).

The influence of the possible existence of a scalar meson mass 380 on the picture of nuclear forces is discussed, and it is pointed out that such a particle would give rise to a strong spin-orbit coupling. (auth)

19155 POLARIZATION OF PROTONS SCATTERED FROM NEON. L. Drigo, C. Manduchi, G. C. Nardell, M. T. Russo-Manduchi, and G. Zannoni (Universita, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cimento (10), 35: 690-3(Jan. 16, 1965).

The polarization of protons scattered from neon was measured by employing proper energy and angular discrimination and attempting to define the details of the energy-angle variation of the polarization. The measurements covered the proton energy from 4.49 to 4.43 Mev and mean scattering angles ranging correspondingly from 52.5 to 127.5°. (C.E.S.)

19156 A CONTRIBUTION TO THE STUDY OF 21-j COEFFICIENTS. G. Ponzano (Universita, Turin). Nuovo Cimento (10), 36: 385-91(Mar. 16, 1965).

Eight different kinds of 21-j symbols are considered: their graphical representations and symmetries are studied in detail; expressions in terms of lower-order symbols are given as well. (auth)

19157 ANALYSIS AND INTERPRETATION OF ^3H AND ^3He FORM FACTORS. [PART] II. A. Q. Sarker (Univ. of California, San Diego, La Jolla). Nuovo Cimento (10), 36: 392-400(Mar. 16, 1965).

A detailed analysis of the form factors of ^3H and ^3He was made to examine the influence of various assumptions upon quantities determined from the form factors of ^3H and ^3He. It is found that meson exchange currents and SD state (apart from their large contributions to the magnetic moment form factors of ^3H and ^3He) may also contribute to the charge form factors of ^3H and ^3He, in particular at high q^2 values. The probability of an S' state of mixed spatial symmetry was estimated from 0% to 2%, which is in agreement with other observations. The analysis shows that the Gaussian wave function is slightly preferred to the Irving and exponential wave functions for the three-nucleon systems. It is concluded that the role of e-^3H, ^3He scattering experiments as independent means of determining the charge form factor of the neutron within reasonable accuracy is rather uncertain. (auth)

19158 DISPERSION THEORY AND EXCHANGE CURRENTS IN NUCLEI. A. Q. Sarker (Univ. of California, San Diego, La Jolla). Nuovo Cimento (10), 36: 401-9(Mar. 16, 1965).

The pion exchange current contribution to the form factor of model deuteron is discussed. Starting from the idea of the Feynman diagram of exchange current, this contribution is then separated out from the rest of the direct current in dispersion theory in the lowest (4-th) order of approximation. Higher order contributions may not have the simple meaning of being exchange currents and are not, in general, separable in dispersion theory. A practicable method of evaluating these pion exchange current contributions to the form factors of light nuclei, such as ^2H, ^3H, and ^3He, is suggested. (auth)

19159 TWO-PION EXCHANGE CURRENT CONTRIBUTIONS TO THE FORM FACTORS OF ^3H AND ^3He. A. Q.

Sarker (Univ. of California, San Diego, La Jolla). Nuovo Cimento (10), 36: 410-18(Mar. 16, 1965).

Two-pion exchange current contributions to the form factors of ^{3}H and ^{3}He were calculated. Further pion-pion rescattering correction was taken into account to enhance this contribution. As full unitarity condition has not been imposed on the amplitudes, the results of calculations depend upon a cut-off parameter, which was fixed arbitrarily. The calculated (magnetic moment) form factors were compared with those obtained from the analysis of the experimental results. (auth)

19160 A GENERALIZED BOGOLYUBOV TRANSFORMATION AND NEUTRON-PROTON PAIRING IN NUCLEI. P. Camiz (Istituto Nazionale di Fisica Nucleare, Rome), A. Covello, and M. Jean. Nuovo Cimento (10), 36: 663-8 (Mar. 16, 1965).

A generalization of the pairing interaction for identical particles effective only in J = 0, T = 1 states of a pair of nucleons is presented. The discussion is limited to the degenerate model (single j shell), and the most general Bogolyubov transformation, which mixes neutrons and protons and at the same time conserves angular momentum and mixes particles and holes as does the usual transformation, is defined. Only a charge-independent pairing interaction is considered. (C.E.S.)

19161 THE ωNN AND φNN COUPLING CONSTANTS. E. Gotsman (Soreq Research Establishment, Yavne, Israel). Nuovo Cimento (10), 36: 680-4(Mar. 16, 1965).

The validity of approximations made in several recent attempts to explain nuclear forces using one-boson-exchange models is investigated. In these attempts isoscalar vector mesons, i.e., the ω and/or φ, were included in order to obtain agreement with existing potentials or experimental N-N phase-shift data. (C.E.S.)

19162 VELOCITY DEPENDENT POTENTIAL AND DEUTERON STRIPPING REACTIONS. A. Y. Abul-Magd and M. El-Nadi (Atomic Energy Establishment, Cairo). Phys. Letters, 14: 204-6(Feb. 1, 1965).

The transition amplitude for deuteron stripping reactions was obtained in the distorted wave Born approximation, and the effect of a velocity dependent potential on the cross sections was investigated. Calculations were made of the velocity dependent and the finite range correction factors for the ^{12}C(d,p)^{13}C reaction at 10 and 20 Mev. It is concluded that the velocity dependence corrections are not expected to be drastic at moderate energies, except in possibly suppressing contributions from the nuclear interior, in a way similar to that of the finite range corrections. (L.B.S.)

19163 POSITION RADIATION OF Tm^{165} AND A POSSIBLE THREE-PARTICLE STATE IN Er^{165}. Z. Preibisz, W. Kurcewicz, K. Stryczniewics, and J. Zylicz (Inst. of Nuclear Research, Warsaw). Phys. Letters, 14: 206-8 (Feb. 1, 1965).

The positron spectrum of ^{165}Tm and ^{166}Tm was measured, and the total decay energy and the log ft value for the transition to the 1427.0-kev level of ^{165}Er were determined. The results lead to the suggestion of a three-particle interpretation of this state. (L.B.S.)

19164 STUDY OF THE REACTION $Li^6(p,\gamma)Be^7$ AT 155 Mev. H. Langevin-Joliot, C. Stephan, G. Johnson, and J. Vernotte (Faculte des Sciences, Orsay, France). Phys. Letters, 14: 208-10(Feb. 1, 1965). (In French)

The reaction ^{6}Li(p,γ)^{7}Be and the angular distribution of photons between 40 and 105° were studied, using coincidence of the incident proton, the gamma ray, and the recoil nucleus. A total-absorption Cherenkov counter was used for gamma detection, and a junction semiconductor detector for the protons. Correlation spectra of gamma rays and particles are presented, and the experimental angular distributions are compared with Born-approximation values for two different wave functions. (M.J.T.)

19165 EXCITATION OF AN M1 TRANSITION IN B^{10} AT 7.48 Mev BY INELASTIC ELECTRON SCATTERING. E. Spamer and F. Gudden (Technische Hochschule, Darmstadt, Ger.). Phys. Letters, 14: 210-12(Feb. 1, 1965).

The spectrum of electrons inelastically scattered through 141° from a 96% enriched ^{10}B target was measured at an incident energy of 55 Mev up to an excitation energy of 20 Mev. Two peaks were observed at excitation energies 6.02 and 7.48 Mev. Reduced transition probabilities were calculated from measured cross sections, and the existence of a strong M1 transition was confirmed. (L.B.S.)

19166 MAGNETIC PROPERTIES OF K EQUALS $\frac{1}{2}$ ROTATIONAL BAND IN Tm^{171}. Y. K. Agarwal, C. V. K. Baba, and S. K. Bhattacherjee (Tata Inst. of Fundamental Research, Bombay). Phys. Letters, 14: 214-16(Feb. 1, 1965).

The magnetic properties of the (411) K = $\frac{1}{2}$ rotational bands in ^{169}Tm and ^{171}Tm are summarized, and a partial level scheme of ^{171}Tm is presented. A γ-γ directional correlation accepting the composite 120 kev and the composite 300 kev peaks of the γ spectrum of ^{171}Tm was measured; and the resultant directional correlation coefficients were measured using both a solid polycrystalline source and a liquid source of $ErCl_3$. The results of both measurements yield the same result, which agrees with the calculated value. The magnetic moment of the $^7/_2{}^+$ state was measured by an integral method, and a value of 0.94 ± 0.18 nm was obtained. (L.B.S.)

19167 QUADRUPOLE FISSION OF ^{238}U. A. S. Soldatov, G. N. Smirenkin, S. P. Kapitza, and Y. M. Tsipeniuk (Inst. of Physics and Energetics, Obninsk, USSR). Phys. Letters, 14: 217-19(Feb. 1, 1965).

The angular distributions of photofission of ^{238}U by bremsstrahlung were measured at 5.2 to 9.25 Mev, and the region where dipole fission is subbarrier (E < 6 Mev) was studied. The energy dependence of a/b and c/b and the total photofission cross section of ^{238}U are presented, (where a, b, and c are coefficients in the angular distribution function). The results show the ratio of quadrupole to dipole fission cross sections. The conjecture of Bohr's hypothesis that the lowest excitation states at saddle point have a zero angular momentum component is confirmed. (L.B.S.)

19168 A MIXED E1, M2, E3 TRANSITION IN THE DECAY OF THE 5.10 Mev LEVEL OF N^{14}. R. S. Blake, D. J. Jacobs, J. O. Newton, and J. P. Schapira (Univ. of Manchester, Eng.). Phys. Letters, 14: 219-20(Feb. 1, 1965).

Angular correlations between protons leading to the 5.10-Mev state and the decay gamma rays to the ground state and to the 2.31-Mev 0^+, T = 0 state were measured by the ^{12}C(^{3}He,p)^{14}N reaction at 4.9 Mev. The mixing ratios of the 5.10-Mev transition were determined, and it was found that three multipoles make significant contributions to the transition. The evidence was insufficient to establish an enhancement in the E3 transition. (L.B.S.)

19169 ELASTIC AND INELASTIC SCATTERING OF 44 Mev ALPHA PARTICLES BY Ni^{60}, Ni^{62}, Sn^{116}, AND Pb^{208} BETWEEN 30 AND 170° c.m. G. Bruge, J. C. Faivre, H. Faraggi, J. Saudinos, and G. Vallois (Centre d'Etudes Nucleaires, Saclay, France). Phys. Letters, 14: 221-2(Feb. 1, 1965). (In French)

Angular distributions observed in elastic and inelastic scattering of 44-Mev α particles are given for ^{62}Ni, ^{116}Sn, and ^{208}Pb for different Q-values. The results are examined in the framework of the diffraction model of Drozdov, Blair, Sharp, and Wilets. Two types of phase relations between elastic and inelastic scattering are observed, as predicted by the model: those characterizing one-phonon and two-phonon excitations. These relations between the phases support the concept of coupling between the two types of scattering, even to angles of 170°. (M.J.T.)

19170 THE $S^{32}(\gamma,n)S^{31}$ CROSS SECTION. M. N. Thompson, J. M. Taylor, and D. V. Webb (Univ. of Melbourne). Phys. Letters, 14: 223-5(Feb. 1, 1965).

A high resolution measurement of the cross section of the ^{32}S(γ,n)^{31}S reaction from threshold to 22.1 Mev is reported. The yield curve was determined at 50 kev intervals by detecting the annihilation radiation from the 2.6 s ^{31}S position activity, and the integrated cross section was found to be 64 ± 7 Mev · mb. (L.B.S.)

19171 INTERMEDIATE STRUCTURE AND CHANNEL COUPLING THEORY. M. E. Haglund and D. Robson. (Florida State Univ., Tallahassee). Phys. Letters, 14: 225-7(Feb. 1, 1965).

The R-matrix theory, which involves a complete set of discrete compound nucleus states, is used to investigate intermediate structure phenomenon. The validity of the theory was examined by solving numerically a set of coupled equations occurring in Feshbach channel coupling theory. Calculations were also performed for complex energies to relate the observed resonance to S-matrix poles. (L.B.S.)

19172 A MICROSCOPIC DESCRIPTION OF INELASTIC SCATTERING. APPLICATION TO NICKEL ISOTOPES. N. K. Glendenning and M. Veneroni (Univ. of California, Berkeley). Phys. Letters, 14: 228-30(Feb. 1, 1965).

Inelastic scattering on even single-closed-shell nuclei is investigated using the distorted wave Born approximation, a finite range interaction between the projectile and the nucleons of the target, and a microscopic description of the states of the nucleus. The form factors of excited states of the even isotopes of nickel from mass 58 to 66 were computed for alpha scattering, and the results are discussed. (L.B.S.)

19173 CALCULATION OF M2 LIFETIMES OF $d_{3/2}$-HOLE STATES IN SCANDIUM ISOTOPES. R. K. Bansal and J. B. French (Univ. of Rochester, N. Y.). Phys. Letters, 14: 230-2(Feb. 1, 1965).

A model for M2 transitions in Sc isotopes is presented, which allows coupling of the proton hole to the ground state and to parent states of Ti of minimum isobaric spin. The spectioscopic amplitudes for ^{43}Sc and ^{45}Sc were calculated, and the admixture due to quadrupole parts of the $d_{\frac{3}{2}}$-$f_{\frac{7}{2}}$ shell-model interaction was investigated. The matrix elements for ^{44}Ti and ^{46}Ti were calculated using the $f_{\frac{7}{2}}$-shell wave functions, and the quadrupole parameters (γ_{20} and γ_{21}) were determined. (L.B.S.)

19174 THE INFLUENCE OF PAIRING IN THE PASSAGE OF TWO PARTICLES THROUGH THE POTENTIAL BARRIER. V. I. Goldanskii (Inst. of Chemical Physics, Moscow). Phys. Letters, 14: 233-4(Feb. 1, 1965).

The probability of penetration through the purely Coulomb barrier for two single protons and for the paired diproton is compared. A numerical example of the 2 p-decay of ^{58}Ge is presented. (L.B.S.)

19175 THE EXCITED CORE MODEL OF LIGHT NUCLEI IN (α,α') SCATTERING. J. Kokame, K. Fukunaga, and H. Nakamura (Kyoto Univ.). Phys. Letters, 14: 234-6 (Feb. 1, 1965).

The predictions of a model in which an excited core is coupled to a hole in the core are tested by alpha-particle scattering from slightly deformed light nuclei. Angular distributions of elastic and inelastic scattering of 28.5-Mev alpha particles from ^{28}Si and ^{27}Al are compared, and fairly good agreement with predictions of the excited core model was found except for the inelastic scattering cross section to the $\frac{5}{2}^+$ level at 2.73 Mev of ^{27}Al. (L.B.S.)

19176 POLARIZATION IN INELASTIC SCATTERING OF 155 Mev PROTONS ON C^{12}. M. Perrain and N. Vinh Mau (Faculte des Sciences, Bordeaux). Phys. Letters, 14: 236-8(Feb. 1, 1965).

Calculations are made of the polarization of 155-Mev protons inelastically scattered by ^{12}C based on the plane wave impulse approximation. An expression for the polarization is obtained using the inelastic and the free nucleon-nucleon scattering amplitudes, and the results for the excitation of the 2^+ T = 0 state at 4.43 Mev are shown. Comparison is made of the theoretical curves and the experimental points for the excitation of other states of ^{12}C, and the results are discussed. (L.B.S.)

19177 TWO-BODY BREAKUPS FOLLOWING π^- ABSORPTION IN LITHIUM: EVIDENCE FOR THE PRODUCTION OF H^4. R. C. Cohen, A. D. Kanaris, S. Margulies, and J. L. Rosen (Columbia Univ., New York). Phys. Letters, 14: 242-5(Feb. 1, 1965).

An experiment is described, which yields evidence for the $\pi^- + {}^6\text{Li} \rightarrow {}^3\text{H} + {}^3\text{H}$, $\pi^- + {}^6\text{Li} \rightarrow {}^2\text{H} + {}^4\text{H}$, and $\pi^- + {}^7\text{Li} \rightarrow {}^3\text{H} + {}^4\text{H}$ reactions. Collinear particle pairs following pion absorption were detected in two counter telescopes, and two-body reaction products were identified from their unique ranges by varying the thickness of an aluminum absorber in one telescope. Differential range curves are presented. It is concluded that the observed reactions occurring with probabilities of one in a few thousand indicate that capture yielding nucleon clusters is appreciable enough to be measured accurately, and evidence is provided for the existence of a ^{4}H state which is unstable against decay into ^{3}H + n. Results for the $\pi^- + {}^7\text{Li} \rightarrow {}^2\text{H} + {}^5\text{H}$ reaction were inconclusive. (L.B.S.)

19178 MUON ABSORPTION IN LIQUID HYDROGEN. P. K. Kabir (CERN, Geneva). Phys. Letters, 14: 257-60 (Feb. 1, 1965).

A detailed investigation of the wave function of the (pμp) system was made for calculation of the muon absorption rate in the ortho-(pμp) ion. The non-relativistic Schroedinger equation was used for the system, and an approximate eigenfunction was found by the Ritz variational method. The axial vector and induced pseudoscalar coupling constants for μ-capture are considered for comparing the theoretical predictions with experimental results. (L.B.S.)

19179 NUCLEAR DOUBLE RESONANCE OF Ca^{43} IN CaF_2. R. E. Walstedt, D. A. McArthur, and E. L. Hahn (Univ. of California, Berkeley). Phys. Letters, 15: 7-8 (Mar. 1, 1965).

A nuclear double resonance method was used to observe NMR of ^{43}Ca (0.13%) in CaF_2. The abundant "A" spin system (^{19}F) is prepared by adiabatic demagnetization in the rotating frame. The temperature T_A of the dipolar reservoir then relaxes back to room temperature by means of spin-lattice relaxation processes. The double resonance method shortens this warm-up time by applying an r-f field at a frequency equal to the rare B-spin (^{43}Ca) Larmor frequency, while an audio-frequency field is applied parallel to the steady field. The audio power absorbed leaks to the A-spin reservoir by means of A-B dipolar interactions, producing an accelerated rise in T_A. The observed double resonance warm-up rate is compared with a value calculated using time-dependent perturbation theory. (M.J.T.)

19180 THE SPIN OF THE SECOND EXCITED STATE OF Ca^{44+}. S. M. Matin, D. J. Church, R. Horoshko, and G. E. Mitchell (Columbia Univ., New York). Phys. Letters, 15: 51-2(Mar. 1, 1965).

Inelastic proton scattering at 4.06 Mev was used to populate the second excited state (1.88 Mev) of ^{44}Ca. Gamma-gamma correlations between the 0.72- and 1.16-Mev gamma rays were measured, for four angular correlations in four geometries. Results for three of the geometries are presented and compared with calculated values for an assumed spin value of 0. Computer calculations for spins of 0 to 4 for the 1.88-Mev state were carried out, analyzing gamma-gamma correlations; the best fit was for spin 0 with X^2 = 0.7. (M.J.T.)

19181 ON THE POLARIZATION IN ELASTIC SCATTERING. J. Huefner and A. De-Shalit (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Letters, 15: 52-5(Mar. 1, 1965).

The relation between the differential cross section and the angular dependence of the polarization in elastic scattering is investigated. Expressions for the polarization and the cross section are obtained using the scattering matrix for spin-$\frac{1}{2}$ particles on a spin-0 target; an analytic expression for the polarization is derived, making assumptions valid mostly only for forward angles. Experimental values for cross sections and polarizations in proton elastic scattering on Cu at 9.4 Mev. and on D at 40 Mev are compared with calculated ones. Elastic scattering of spin-1 particles was also investigated for the case of Ca(d,d)Ca at 22 Mev. (M.J.T.)

19182 Br^{82m} AND ITS DECAY SCHEME. Oswald U. Anders (Dow Chemical Co., Midland, Mich.). Phys. Rev., 138: B1-8(Apr. 12, 1965).

The discovery of a new activity of bromine is reported

and is assigned to a 2(–) isomeric state of ^{82}Br. The new activity is chemically identified as bromine and shown to be the short-lived parent of ^{82}Br. It decays primarily by a highly converted M3 transition (α = 382 ± 75) of 46 kev to the 5(–) ground state of ^{82}Br. Two weak branches in the proposed decay scheme lead by beta emission to the 0.78-Mev level (0.15%) and the 1.48-Mev level (0.024%) of ^{82}Kr. Time-dependent gamma spectra, obtained with a large anticoincidence counter, demonstrate the growth of the 2.65-Mev sum peak of ^{82}Br after thermal-neutron activation of NH_4Br. Short-lived gamma peaks at 46 kev, 0.78 Mev, and 1.48 Mev were observed in the gamma spectra of an activated sample of enriched NH_4Br (99.32% ^{81}Br). X-ray spectra of activated NH_4Br taken with an argon-methane proportional counter provide evidence that the short-lived component is a thermal-neutron activation product. One-component decay curves of the Kr K x rays over more than 6 half periods define the half life of ^{82m}Br as 363 ± 2 sec. (auth)

19183 LEVELS IN Rh^{101} POPULATED BY THE DECAY OF Pd^{101}. J. S. Evans, E. Kashy, R. A. Naumann, and R. F. Petry (Princeton Univ., N. J.). Phys. Rev., 138: B9-17 (Apr. 12, 1965). (PPAD-530-E)

The decay of 8.4-h ^{101}Pd was investigated using high-resolution gamma- and conversion-electron spectroscopy. Strong K, L, and M conversion lines of a 157.32 ± 0.03-kev transition converted in rhodium are observed to grow in initially pure ^{101}Pd sources and ultimately to decay with a half life of 4.43 ± 0.06 days. This isomeric transition is classified as M4 on the basis of its radiative lifetime of (1.3 ± 0.3) × 10^9 sec. Other transitions attributed to ^{101}Pd decay were observed with energies 24.46, 269.60, 296.13, 320.7, 453.2, 565.5, 590.3, 723.4, 748.3, 992.6, 1177.2, 1202.1, 1218.6, 1289.3, and 1312.8 kev. Energy-sum relations and coincidence studies reveal levels in ^{101}Rh with the following energies, spins, and inferred parities: 0 ($\frac{1}{2}$–), 157.32 ($\frac{3}{2}$+), 181.78 ($\frac{1}{2}$+), 477.9 ($\frac{5}{2}$+), 747.5 ($\frac{1}{2}$+), 905.3 (+), 1359.2 (+), and 1470.6 (+) kev. The ground-state spin and parity $\frac{5}{2}$+ is suggested for ^{101}Pd. A comparison is made between the energy levels of ^{101}Rh as found in this investigation and the properties of low-lying levels reported for neighboring nuclei. The existence of additional collective states in ^{101}Rh is suggested. (auth)

19184 NEW DELAYED-NEUTRON-EMITTING ISOTOPE: Be^{12}. A. M. Poskanzer, P. L. Reeder, and I. Dostrovsky (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 138: B18-20(Apr. 12, 1965). (BNL-8620)

Delayed neutrons with a half life of 11.4 ± 0.5 msec were observed in the Bev-energy proton irradiation of targets of ^{15}N and heavier nuclei but not from ^{14}N and lighter nuclei. This new activity was assigned to ^{12}Be. Cross sections for production of this nuclide from ^{15}N, ^{16}O, ^{18}O, F, Na, and Al were measured. From cross section systematics, it is estimated that delayed neutrons are emitted in about 7% of the decays. Upper limits for the delayed-neutron branches of ^{8}He and ^{13}B were set at 3 and 0.3%, respectively. (auth)

19185 STUDY OF THE GAMMA-RAY SPECTRA EMITTED IN THE RESONANCE CAPTURE OF NEUTRONS BY ^{19}F. J. R. Bird, J. A. Biggerstaff, J. H. Gibbons, and W. M. Good (Oak Ridge National Lab., Tenn.). Phys. Rev., 138: B20-5(Apr. 12, 1965). (ORNL-P-790)

Gamma spectra were measured at the 27-kev (2^-) and the 49-kev (1^-) resonances of $^{19}F(n,\gamma)^{20}F$. The E1 transition to ground is virtually absent at both resonances, while the other E1's have strengths that appear normal when compared with heavier nuclei in which the radiation widths are proportional to level spacing. A description is given of the two-parameter instrument by means of which it is possible to measure simultaneously the neutron energy (flight time) and gamma pulse-height spectra for radiative neutron capture. (auth)

19186 P- AND D-STATE CONTRIBUTIONS TO THE CHARGE FORM FACTORS OF H^3 AND He^3. B. F. Gibson and L. I. Schiff (Stanford Univ., Calif.). Phys. Rev., 138: B26-32(Apr. 12, 1965).

The method of Sachs is used to obtain explicit expressions for the P- and D-state components of the ground-state wave functions of ^{3}H and ^{3}He, under the assumption that they have T = ½ and $J^P = \frac{1}{2}^+$. The effect of a reasonable admixture of these components on the electric charge form factors of the two nuclei is calculated, and is found that the striking difference between the observed charge form factors cannot be accounted for in this way. It seems most likely that a combination of S'-state and T = $\frac{3}{2}$-state admixture might provide an explanation of this effect without leading to disagreement with other experimental observations. (auth)

19187 GAMMA-GAMMA DIRECTIONAL CORRELATIONS IN THE DECAY OF Tb^{160}. K. Venkata Reddy, B. B. Venkatapathi Raju, R. V. RamaMohan, and Swami Jnanananda (Andhra Univ., Waltair, India). Phys. Rev., 138: B33-7 (Apr. 12, 1965).

Gamma-gamma directional correlation measurements were made in the decay of ^{160}Tb–^{160}Dy, for the cascades, 87–197, 87–877, 87–960, 87–1173, 197–680, 197–1250, and 298–877 kev. The corresponding angular correlation functions were obtained. (auth)

19188 LOW-ENERGY BETA-RAY TRANSITION IN THE DECAY OF I^{128}. Lawrence J. Pilione and William W. Pratt (Pennsylvania State Univ., University Park). Phys. Rev., 138: B38-40(Apr. 12, 1965).

The gamma spectrum of ^{128}I was investigated with a scintillation well counter and auxiliary coincidence apparatus to search for a beta transition to a high-energy ^{128}Xe level. A transition to an excited state at 1570 ± 30 kev in ^{128}Xe was observed to take place with a probability of (6 ± 3) × 10^{-3}%. The deexcitation of this state takes place primarily by way of the first excited state, the probability of gamma decay directly to the ground state being less than 10%. The energy of the second excited state is found to be 975 ± 15 kev. (auth)

19189 PHASE-SHIFT ANALYSIS FOR $He^3(p,p)He^3$. T. A. Tombrello (California Inst. of Tech., Pasadena). Phys. Rev., 138: B40-7(Apr. 12, 1965).

A phase-shift analysis based on the scattering and polarization data for the reaction $^3He(p,p)^3He$ was made for proton energies between 1.0 and 11.5 Mev. The singlet and triplet S-wave phase shifts are found to be negative and approximately equal; they are in good agreement with the resonating-group calculations of Bransden and Robertson. The P-wave phase shifts are positive and increase with energy; a single-level parametrization of these phase shifts indicates the possible presence of triplet states with $J^\pi = 2^-, 1^-, 0^-$ at center-of-mass energies 4.74, 6.15, and 7.94 Mev above the p+ ^{3}He threshold. All three levels have reduced widths that are comparable with the Wigner limit. The presence of a broad singlet 1^- level at 9.8 Mev is indicated with somewhat less confidence. (auth)

19190 STUDIES OF NEUTRON COMPOUND-ELASTIC SCATTERING NEAR 1 Mev. D. J. Hooton (Univ. of Auckland, N. Z.). Phys. Rev., 138: B48-50(Apr. 12, 1965).

A Hauser-Feshbach calculation of neutron compound-elastic scattering from Fe, Ni, Cu, Zn, Mo, and Cd in the energy range 0.2-2.0 Mev is made in order to investigate its variation with target and with energy. Transmission coefficients are fixed in terms of the optical nonelastic cross section, and attention is paid to the influence of nonzero target spin. (auth)

19191 $F^{19}(d,\alpha)O^{17}$ REACTION AT 9.2 Mev. S. W. Cosper, B. T. Lucas, and O. E. Johnson (Purdue Univ., Lafayette, Ind.). Phys. Rev., 138: B51-7(Apr. 12, 1965). (COO-1420-105)

The differential cross sections for the $^{19}F(d,\alpha)^{17}O$ reaction which leave ^{17}O in its ground and lowest four excited states were measured using silicon surface-barrier detectors. Thin Teflon targets (370 to 720 $\mu g/cm^2$) were bombarded with 9.2-Mev deuterons and alpha spectra were obtained at 46 laboratory angles between 10 and 172.5°. The five angular distributions exhibited forward and backward peaking, an over-all oscillatory structure, and minima

whose magnitudes differ significantly from zero. The angular distributions are analyzed in terms of an expression which is the sum of an isotropic term and one which arises from the simultaneous action of two-nucleon pickup and heavy-particle stripping (HPS) mechanisms. Good fits are obtained for the α_0, α_2, and α_4 distributions, but only the gross features of the α_1 and α_3 distributions could be fitted. A discussion regarding the identification of either the pickup or the knockout mechanism as the dominant forward-angle direct-interaction process for (d,α) reactions in light nuclei is presented. It is concluded that the experimental angular distributions are fitted equally well-irrespective of which one is assumed to act along with HPS. An interpretation of the differential cross sections is made which is based on the speculation that direct-interaction and statistical compound-nucleus (SCN) processes contribute incoherently. A method for the decomposition of the cross section is proposed in which the SCN contribution is assumed to be isotropic. The integrated SCN component of the cross sections is shown to be closely proportional to 21 + 1. (auth)

19192 ELASTIC ELECTRON SCATTERING FROM TRITIUM AND HELIUM-3. H. Collard (Stanford Univ., Calif.), R. Hofstadter, E. B. Hughes, A. Johansson, M. R. Yearian, R. B. Day, and R. T. Wagner. Phys. Rev., 138: B57-65(Apr. 12, 1965). (LA-DC-6755)

The mirror nuclei of tritium and helium-3 were studied by the method of elastic electron scattering. Absolute cross sections were measured for incident electron energies in the range 110–680 Mev at scattering angles lying between 40 and 135° in this energy range. The data were interpreted in a straightforward manner and form factors are given for the distributions of charge and magnetic moment in the two nuclei over a range of four-momentum transfer squared 1.0–8.0 F^{-2}. Model-independent radii of the charge and magnetic-moment distributions are given, and an attempt is made to deduce form factors describing the spatial distribution of the protons in tritium and helium-3. (auth)

19193 MULTICHANNEL REACTIONS AND THE NUCLEAR SURFACE. Albert Altman (Naval Ordnance Lab., Silver Spring, Md. and Univ. of Maryland, College Park). Phys. Rev., 138: B78-86(Apr. 12, 1965).

The differential equations relating the behavior of the reduced widths and eigenvalues in a nuclear reaction to an exterior potential are derived for a general multichannel region. A multichannel sum rule is also obtained. The developed equations show coupling of the reduced widths of a particular level and channel to that of all other levels and channels. The degree of coupling is governed by the strength of the exterior potential and the proximity of other levels. The Vogt prescription of modification of the penetration factor is then seen to be valid when the external potential is weak. (auth)

19194 RELATIVISTIC EFFECTS IN MUON CAPTURE BY COMPLEX NUCLEI. R. Klein (New York Univ., New York), T. Neal, and L. Wolfenstein. Phys. Rev., 138: B86-92(Apr. 12, 1965). (TID-21418)

Relativistic contributions to muon capture by complex nuclei are considered. For the total rate calculated for a Fermi gas in the closure approximation these contributions increase the rate by about 15% for elements between Ca and Pb. The neutron asymmetry (with respect to the muon spin direction) near the top of the neutron spectrum is decreased in magnitude from a value of about −0.4 to about −0.1 by these contributions. A calculation using the Fermi-gas model for N = Z indicates that the neutron asymmetry has a magnitude less than 0.15 for all neutron energies, a result which is in disagreement with experiment. (auth)

19195 SHELL-MODEL TREATMENT OF NUCLEAR REACTIONS. Michael Danos (National Bureau of Standards, Washington, D. C.) and Walter Greiner. Phys. Rev., 138: B93-103(Apr. 12, 1965).

A method is developed for the calculation of resonant nuclear states which preserves as many features of the shell model as possible. It is an extension of the R-matrix theory. The necessary formulas are derived and a detailed description of the computational procedure is given. The method is valid up to the two-particle emission threshold. With the assumption of consecutive decay of the nucleus, the two-particle emission process can also be described. The treatment is antisymmetrized in all particles. (auth)

19196 ANGULAR-CORRELATION STUDIES FOR THE $C^{12}(He^3,\alpha\gamma)C^{11}$, $C^{12}(He^3,p\gamma)N^{14}$, AND $O^{18}(p,\alpha\gamma)N^{15}$ REACTIONS. E. K. Warburton, J. S. Lopes, R. W. Ollerhead, A. R. Poletti, and M. F. Thomas (Oxford Univ.). Phys. Rev., 138: B104-16(Apr. 12, 1965). (BNL-8596)

The particle-gamma angular correlation method of Litherland and Ferguson was used to gain information on the decay modes and spin assignments of the ^{11}C 2.00-Mev level; the ^{14}N 5.83- and 7.03-Mev levels; and the ^{15}N 5.28-, 6.33-, 8.31-, and 8.57-Mev levels. The $^{12}C(^3He,\alpha)^{11}C$, $^{12}C(^3He,p)^{14}N$, and $^{18}O(p,\alpha)^{15}N$ reactions were used to populate the levels. Protons and α particles were detected in an annular counter at 170° to the beam and gamma rays were detected at angles between 20 and 90° to the beam. The spin of the ^{11}C 2.00-Mev level was found to be $\frac{1}{2}$, $\frac{3}{2}$, or $\frac{5}{2}$ with the quadrupole-dipole mixing parameter of the 2.00 → 0 transition given by $x = +(0.27 \pm 0.07)$, or $|x| < 11$ for $\frac{3}{2}$ and $x = -(0.18 \pm 0.07)$ for $\frac{5}{2}$. The angular distribution of the ^{14}N 7.03 → 0 transition gave $0.15 \leq x \leq 1.15$ for this J = 2 to J = 1 transition. A 7.03 → 3.95 transition was observed with a branching ratio of 9 ± 5%. The results for the ^{14}N 5.83-Mev level were consistent with earlier work. The ^{15}N 5.28-Mev level was assigned $J^\pi = \frac{5}{2}^{(+)}$ with a value of $-(0.15 \pm 0.06)$ or $+(6.1 \pm 1.4)$ for the octupole-quadrupole mixing ratio of the 5.28 → 0 transition. The ^{15}N 6.33-Mev level was assigned $J^\pi = \frac{3}{2}^{(-)}$ with a value of $+(0.09^{+0.08}_{-0.03})$ or $+(1.4^{+0.4}_{-0.3})$ for the 6.33 → 0 mixing ratio. Most probable assignments of $\frac{1}{2}^+$ and $\frac{3}{2}^+$ are made to the ^{15}N 8.31- and 8.57-Mev levels on the basis of this and previous work. The results are compared to shell-model predictions. (auth)

19197 DIRECT OBSERVATION OF THE OPTICAL ANISOTROPY OF THE HOLMIUM NUCLEUS. E. Ambler, E. G. Fuller, and H. Marshak (National Bureau of Standards, Washington, D. C.). Phys. Rev., 138: B117-26 (Apr. 12, 1965).

The optical anisotropy of the holmium nucleus in the giant-resonance energy region has been shown to exist by measuring the yield of photoneutrons as a function of the orientation of the nucleus with respect to a bremsstrahlung beam direction. The nuclei were aligned by the Bleaney method using a continuously operating ^3He refrigerator to cool a single crystal of holmium ethyl sulfate to 0.29°K. The orientation effects observed could be explained if the absorption cross section for holmium was made up primarily of a component given by the dynamic collective theory, but also included a small scalar component (about 15% of the total) which had no orientation effects associated with it. In fitting the data, a reanalysis of previous data on the holmium absorption cross section was made. (auth)

19198 MEASUREMENTS OF THE MUON-CAPTURE RATE IN He^3 AND He^4. Leonard B. Auerbach, Robert J. Esterling, Roger E. Hill, David A. Jenkins, Joseph T. Lach, and Norman H. Lipman (Univ. of California, Berkeley). Phys. Rev., 138: B127-44(Apr. 12, 1965). (UCRL-11004 (Rev.))

In order to test the universality of the V–A Fermi interaction and the presence of the induced pseudoscalar term in the hamiltonian, the rate of the reaction $\mu^- + {}^3He \rightarrow {}^3H + \nu_\mu$ was measured. This reaction is closely analogous to the fundamental muon-capture interaction $\mu^- + p \rightarrow n + \nu_\mu$. The total muon-capture rates in ^3He and ^4He; the rates for the reactions $\mu^- + {}^3He \rightarrow$ all final states and $\mu^- + {}^4He \rightarrow$ all final states, were measured. Negative muons were brought to rest in a high-pressure helium-gas target. The capture processes all yield a charged particle, whose energy was measured by observation of scintillation in the helium gas. Captures into the ^3H channel were recognized by the unique energy (1.9 Mev) of the triton recoil. The total capture rates obtained were: $\Lambda(^3He) = 2170\ sec^{-1}$, and $\Lambda(^4He) = 375\ sec^{-1}$. The partial capture rate to the triton ground state was measured as $\Lambda(^3He \rightarrow {}^3H) = 1505 \pm 46\ sec^{-1}$. These results are in good agreement with theoretical predictions based on a universal Fermi interaction, and on a conserved

vector current. They also indicate that the induced-pseudoscalar-coupling coefficient is positive. Interpretation of these results in terms of the fundamental muon-capture process is somewhat ambiguous because of the uncertainty in the structure of the helium nucleus. (auth)

19199 NUCLEAR RECOIL IN THE DECAY OF BOUND MUONS; A POSSIBLE TOOL IN MUONIC-ATOM STUDIES. Richard M. Weiner. Phys. Rev., 138: B210-12 (Apr. 12, 1965).

The nuclear-recoil spectrum in the decay of a bound muon is calculated using sudden perturbation theory and with neglect of the final Coulomb interaction between the μ-decay electron and the nucleus of relativistic corrections to the muon wave function. In this approximation the recoil momentum distribution is identical with the square of the Bessel-Hankel transform of the bound muon wave function. By measuring the recoil spectrum one could gain important information about the muonic atom. (auth)

19200 QUADRUPOLAR RELAXATION OF Xe^{131} IN XENON GAS. Frank J. Adrian (Johns Hopkins Univ., Silver Spring, Md.). Phys. Rev., 138: A403-9(Apr. 19, 1965).

A theoretical study is made of the spin-lattice relaxation of ^{131}Xe ($I = 3/2$) nuclei in pure xenon gas due to collision-induced nuclear electric quadrupole interactions. The calculation treats a pair of colliding Xe atoms as a rotating diatomic molecule, whose nuclear electric quadrupole interaction couples the nuclear spin and rotational angular momenta. This interaction permits the nuclei to relax by exchanging energy with the rotational motion of the colliding atoms. The quadrupole interaction in such a diatomic molecule is computed by considering the effects of exchange and Van der Waals interactions in deforming the spherical electronic charge clouds of the free atoms. It is found that the exchange interaction makes the dominant contribution to the quadrupole interaction. Averaging the single-collision transition probabilities over all types of collisions gives the following result for the spin-lattice relaxation time T_1: $1/T_1 = 0.046\ \rho\ \mathrm{sec}^{-1}$, where ρ is the density in amagats. This is in good agreement with the observed result: $1/T_1 = 0.039\ \rho\ \mathrm{sec}^{-1}$. (auth)

19201 INFLUENCE OF LOCAL PHONON DAMPING ON MÖSSBAUER SPECTRA. M. Lax (Bell Telephone Labs., Murray Hill, N. J.) and I. Waller. Phys. Rev., 138: A523-9(Apr. 19, 1965).

The contribution of localized-mode phonon emission and absorption to the Mössbauer emission process is evaluated in the presence of damping. Net-zero-phonon processes, in which the number of localized phonons (of a given type) emitted is the same as the number absorbed, are shown to contribute to the intensity in the vicinity of the unshifted gamma-ray energy. This contribution is shown to be distributed over a minimum width $\Gamma + 2\gamma$ where Γ is the gamma-ray natural width, and γ, the width of the localized phonon, is larger than Γ. The complete Mössbauer spectrum including all multiphonon contributions can be obtained in the approximation by using the continuous spectrum of nonlocalized phonons plus a Lorentz-broadened peak associated with each localized phonon. Optical absorption at impurities in solids may have linewidths $\Gamma >$ the phonon widths γ, thus permitting local phonon enhancement of the zero-phonon transitions in impurity absorption or emission. (auth)

19202 DELAYED PROTONS IN THE DECAY OF Te^{108}. Antti T. Siivola (Univ. of California, Berkeley). Phys. Rev. Letters, 14: 142-3(Feb. 1, 1965). (UCRL-11834)

Delayed proton emission was observed from Te isotopes produced by reactions of ^{16}O ions with ^{96}Ru. The activity was identified with ^{108}Te. (D.C.W.)

19203 EXACT CALCULATION OF TRITON PARAMETERS WITH REALISTIC POTENTIALS. B. S. Bhakar and A. N. Mitra (Univ. of Delhi). Phys. Rev. Letters, 14: 143-5(Feb. 1, 1965).

The results are presented of an exact calculation of the binding energy, the magnetic moment, and the percentage probabilities of the S, P, and D states for the triton considered as a three-body problem. (D.C.W.)

19204 GAMMA-RAY TRANSITIONS FROM THE 5-Mev DOUBLET LEVELS IN N^{15} AND O^{15}. E. K. Warburton, K. W. Jones, D. E. Alburger, C. Chasman, and R. A. Ristinen (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 14: 146-7(Feb. 1, 1965). (BNL-8734)

The gamma rays produced by the deuteron bombardment of ZrN and ^{14}C targets and by ^{3}He bombardment of a quartz target were studied. It was concluded that in deuteron reactions with ^{14}N, a quartet of lines occurs near 5.3 Mev. The two sharp central lines arise from the ^{15}O, 5.24-Mev and ^{15}N, 5.270-Mev M2,E3 transitions, while the broad components on either side are the ^{15}O, 5.19-Mev and ^{15}N, 5.299-Mev E1 transitions arising from the reactions $^{14}N(d,n)^{15}O$ and $^{14}N(d,p)^{15}N$, respectively. (D.C.W.)

19205 MASS OF Na^{20}. P. F. Donovan and P. D. Parker (Bell Telephone Labs., Murray Hill, N. J. and Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 14: 147-9(Feb. 1, 1965).

The mass of ^{20}Na was determined by measuring the Q value for the reaction $^{20}Ne(^{3}He,t)^{20}Na$. A ground-state Q value of -13.89 ± 0.06 Mev was obtained, together with a mass excess of $+6.83 \pm 0.06$ Mev for ^{20}Na. The energies of the ^{20}Na levels corresponding to the observed triton groups were determined. (D.C.W.)

19206 INGOING-WAVE BOUNDARY-CONDITION ANALYSIS OF ALPHA–Ni^{62} ELASTIC-SCATTERING CROSS SECTIONS. G. Rawitscher (Univ. of California, Berkeley and Max-Planck-Institut fur Kernphysik, Heidelberg). Phys. Rev. Letters, 14: 150-2(Feb. 1, 1965).

An analysis of the cross section for alpha elastic scattering by ^{62}Ni at 25, 33, 50, and 85 Mev, using an ingoing-wave boundary condition, is summarized. (D.C.W.)

19207 M2 LIFETIMES AND CORE EXCITATION IN THE SCANDIUM ISOTOPES. R. D. Lawson and M. H. Macfarlane (Argonne National Lab., Ill.). Phys. Rev. Letters, 14: 152-4(Feb. 1, 1965).

The M2 transitions of the positive-parity first excited states of ^{43}Sc, ^{45}Sc, and ^{47}Sc are studied. It is shown that the M2 matrix elements are very sensitive to the probability of core excitation in the single-hole wave functions. It is concluded that the inhibited M2 decays of the first excited states imply core-excitation probabilities of 0.4 or greater in the positive-parity wave functions. (D.C.W.)

19208 MASS RADII OF H^3 AND He^3 FROM THE D-D REACTION. R. B. Theus, W. I. McGarry, and L. A. Beach (Naval Research Lab., Washington, D. C.). Phys. Rev. Letters, 14: 232-4(Feb. 15, 1965).

The mass radii of ^{3}He and ^{3}H were investigated, using the $^{2}H(d,p)^{3}H$ and $^{2}H(d,n)^{3}He$ reactions. The total cross section ratio for the reactions was calculated for equal and unequal radii, together with the reaction product asymmetries for unequal radii. The results indicate, in comparison with the experimental data, that the mass radius of ^{3}H, as well as the charge radius, is less than that of ^{3}He. (D.C.W.)

19209 ELECTRON SCATTERING FROM THE MAGNETIC DIPOLE AND OCTOPOLE MOMENTS OF BERYLLIUM-9 AND BORON-11. R. E. Rand, R. Frosch, and M. R. Yearian (Stanford Univ., Calif.). Phys. Rev. Letters, 14: 234-7(Feb. 15, 1965).

The magnetic form factors of ^{9}Be and ^{11}B were measured in the range of four-momentum transfer squared up to 6 F^{-2} by electron scattering at 180°. The results were interpreted in terms of form factors for the magnetic dipole and octopole moments of the nuclei. (D.C.W.)

19210 DEPENDENCE OF THE ANGULAR DISTRIBUTION IN THE (α,p) REACTION ON THE TOTAL ANGULAR-MOMENTUM TRANSFER. L. L. Lee, Jr. (Argonne National Lab., Ill.), A. Marinov, C. Mayer-Boricke, J. P. Schiffer, R. H. Bassel, R. M. Drisko, and G. R. Satchler. Phys. Rev. Letters, 14: 261-3(Feb. 22, 1965).

The angular distributions of protons to the $3/2^-$ ground states and $1/2^-$ first excited states of ^{61}Cu and ^{63}Cu in the (α,p) reaction on ^{58}Ni and ^{60}Ni at 18 Mev were measured. The angular distributions for these reactions and the (α,p) reaction on ^{27}Al, ^{24}Mg, ^{28}Si and ^{32}S were calculated for

proton transitions in the 2p and 1d orbitals, using the zero-range distorted-wave Born approximation. It was concluded that the usual distorted-wave theory can produce J-dependent effects of the same qualitative nature and the right order of magnitude when spin-orbit coupling is included in the distorting potentials. The angular distributions for the (α,p) reaction on ^{56}Fe and ^{116}Sn were calculated for proton transitions in the 1f and 2d orbitals. (D.C.W.)

19211 DECAY OF CARBON-9. J. C. Hardy, R. I. Verrall, R. Barton, and R. E. Bell (McGill Univ., Montreal). Phys. Rev. Letters, 14: 376-8(Mar. 8, 1965).

The spectrum of delayed protons following the beta decay of ^{9}C was measured. Two peaks with energies of 12.25 ± 0.20 and 9.25 ± 0.25 Mev and widths of 800 ± 100 and 1400 ± 200 kev were identified. The half-life of ^{9}C was determined to be 127 ± 3 msec, and a partial decay scheme was proposed for ^{9}C. (D.C.W.)

19212 OPTICAL MODEL INTERACTION OF PARTICLES WITH ATOMIC NUCLEI. K. Grotowski (Jagiellon Univ. and Inst. of Nuclear Physics, Krakow). Postepy Fiz., 15: 529-46(1964). (In Polish)

The elastic scattering of nucleons and heavier particles by atomic nuclei is discussed in terms of the optical model. The scattering takes place by shape elastic scattering, in which surface effects of the target nucleus are important, and by compound elastic scattering, by which a nucleon is absorbed and re-emitted without energy loss. Various types of optical potential are reviewed, including spin-orbit interaction. The non-local optical potential is treated, as is the dependence of scattering on isotopic spin, on the coulomb potential, and on strong coupling between elastic and inelastic scattering channels. (TTT)

19213 ANGULAR CORRELATION γ-γ BY THE DISINTEGRATION OF Sc^{46}. A. Gelberg, M. Iovan, P. Kemeny, and R. Mihai (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 717-22(1964). (In French)

The γ-γ directional correlation in the ^{46}Sc decay was investigated with a slow-fast coincidence apparatus and NaI(Tl) detectors. The following angular correlation coefficients were determined. $A_2 = 0.1000 \pm 0.0028$ and $A_4 = 0.021 \pm 0.017$. The results are only consistent with the cascade 4 + (E2) 2 + (E2) 0. The share of M3 in the first transition is limited by $\delta^2 \leq 10^{-5}$. The perturbation of the angular correlation by extranuclear fields does not seem probable. (auth)

19214 EXCITED LEVELS OF ^{55}Fe FROM THE $^{55}Mn(p,n)^{55}Fe$ REACTION. I. R. Lukas, M. T. Magda, N. Martalogu, E. Trutia, and I. Vilcov (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 751-4(1964).

The excited levels in ^{55}Fe, in the 3–4 Mev excitation range were determined by means of the $^{55}Mn(p,n)^{55}Fe$ reaction. Neutron energy spectra were studied by the time-of-flight method. In the 3–4 Mev excitation energy range the following levels were found: 2.96, 3.34, 3.55, 3.76, 3.87, and 4.04 Mev. A comparison was made with the data obtained from other experiments. (auth)

19215 ON THE ANGULAR DISTRIBUTION OF THE NEUTRON POLARIZATION FROM THE 4.9 Mev RESONANCE OF THE $Li^{7}(p,n)Be^{7}$ REACTION. I. Minzatu, A. Calboreanu, N. Martalogu, M. Molea, and R. Dumitrescu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 763-6(1964).

The angular distribution of neutron polarization from the $^{7}Li(p,n)^{7}Be$ reaction resonance at 4.9 Mev was determined. Two peaks for polarization were obtained, one forward and the other backward. This shape of the angular distribution cannot be explained by a compound-nucleus model, as it is concluded. (auth)

19216 COLLECTIVE EFFECTS OF THE SU_3 CLASSIFICATION IN INELASTIC SCATTERING. I. Guiasu and M. Micu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 911-25(1964).

The nuclear states classified according to the irreducible representations of the group SU_3 possess collective properties which influence the inelastic scattering. These properties are investigated, and one derives that the cross section is larger than that obtained by using nuclear states in the extreme j–j or L–S couplings. (auth)

19217 THE CROSS SECTION FOR PHOTONEUTRON PRODUCTION IN Co, Ni, Cu, AND Ga. G. Baciu (Inst. for Atomic Physics, Bucharest), A. Bonazzola, B. Minetti, C. Molino, L. Pasqualini, and G. Piragino. Rev. Roumaine Phys., 9: 977-86(1964).

Measurements were made on the cross section of neutron photoproduction from Co, Ni, Cu, and Ga, as a function of excitation energy from threshold up to 28 Mev. The integrated cross section obtained for these elements are respectively: $\sigma(Co) = 657 \pm 89$ mb Mev; $\sigma(Ni) = 313 \pm 48$ mb Mev; $\sigma(Cu) = 733 \pm 105$ mb Mev; $\sigma(Ga) = 947 \pm 98$ mb Mev. Yield points were taken at 0.5-Mev intervals using a 4π Halpern type detector. Many runs were made at each point resulting in less than 0.06% standard deviation. The data were analyzed in the same energy range using two interlacing 1-Mev bin widths. For the level density expression the Rosenzweig's formula was used taking into account the degeneracy and population number of Fermi levels. (auth)

19218 THE HISTORY OF THE THEORY OF STRUCTURE OF THE ATOMIC NUCLEUS. J. Hans D. Jensen (Universitat, Heidelberg). Science, 147: 1419-23(Mar. 19, 1965).

The background from which concepts of nuclear structure emerged are discussed. Consideration is given to the problems of nuclear structure, nuclear forces, and the problems of elementary particles. (P.C.H.)

19219 BINDING ENERGY OF HYPERTRITIUM IN THE CASE OF A NONLOCAL INTERACTION. I. Sh. Vashakidze and G. A. Chilashvili. Soobshch., [Akad. Nauk Gruz. SSR,] 36: 301-8(1964).

The total binding energy for ^{3}H was determined by solving a system of related integral equations, taking into account the $\Lambda N \rightleftharpoons \Sigma N$ transitions. The following interaction potentials were selected: the V^{YN} potential, representing the hyperon-nucleon interaction $Y + N \rightleftharpoons Y + N$, and the $V^{\Lambda\Sigma}$ and $V^{\Sigma\Lambda}$ potentials, representing the $N + \Lambda \rightleftharpoons \Sigma + N$ processes. By applying a model of global symmetry, relationships connecting potentials of nucleon-nucleon interaction with potentials of hyperon-nucleon and hyperon-hyperon interaction were obtained. Since the hypertritium is in a state in which $T = 0$ and $I = \frac{1}{2}$, the neutron and proton in $_{\Lambda}{}^{3}H$ are characterized by a state ^{3}S, and N-Λ and N-Σ interactions occur in a state ^{1}S. Therefore, the potentials $V^{N\Sigma}$ and $V^{N\Lambda}$ were used only in the singlet state. The binding energy was calculated from Schroedinger equations for hypertritium, taking into account the transitions $\Lambda \rightleftharpoons \Sigma$ in the case of local interaction. Because of the peculiarity of the $_{\Lambda}{}^{3}H$ system, Mitra's approximation was used in solving the equations. In this approximation, the solutions of integral equations are expressed as the functions $\Phi_s^{\Lambda}(\tilde{p})$, $\Phi_s^{\Sigma}(p)$, and $\Phi_t^{\Lambda}(p)$. The total binding energy obtained was $E(_{\Lambda}{}^{3}H) = 2.904$ Mev, which is in agreement with the experimental value ≃2.3 Mev. By going to the limit when the $\Lambda \rightleftharpoons \Sigma$ transitions are not possible, the value for binding energy is 4.6 ev. This result shows that the $\Lambda \rightleftharpoons \Sigma$ transitions are important and should be taken into consideration. (ATD)

19220 SPALLATION OF LIGHT NUCLEI BY SLOW π MESONS. A. T. Varfolomeev. Tr. Fiz. Inst., Akad. Nauk SSSR, 22: 101-28(1964). (In Russian)

The products from the absorption of mesons(π^-) by ^{12}C, ^{14}N, and ^{16}O were measured on Ilford C-2 emulsions 400 microns thick. The meson(π^-) beam was obtained by irradiating carbon targets in the gamma beam of a synchrotron. The angular distributions of the slow fragments are peaked at large angles when compared to the distributions of the fast protons. Average values of the momenta of ^{8}Li, α, and p products were determined for reactions giving charged products of 2αp, 3αp, $^{8}Li2p$, and $^{8}Li\alpha$. It is generally assumed that singly charged products are protons; however in up to 30% of the cases they were determined to be deuterons and tritons. Neutron spectra were determined for the reactions $^{12}C + \pi^- \rightarrow {}^{8}Li + {}^{3}He + n$; $^{12}C + \pi^- \rightarrow 2\alpha + t + n$; and $^{16}O + \pi^- \rightarrow 3\alpha + t + n$. The maximum energies

of the neutron spectra for these reactions are 87, 102, and 97 Mev, respectively. The spectra coincide < 80 Mev, indicating that these neutrons arise from the reaction p + π^- → n. The measured momentum distributions agree better with calculations based on the one-nucleon model (p + π^- → n) than with the two-nucleon model (p + n + π^- → 2n; 2p + π^- → p + n). The distributions of the excitation energy of the ^{11}B nucleus were found to be the same for the ^{12}C(π^-,n)^{11}B and ^{12}C(p,2p)^{11}B reactions above 30 Mev, indicating that excitation states of ^{11}B < 25 Mev are even, but >25 Mev are odd. The only observed reaction on nitrogen was ^{14}N + π^- → 3α + 2n. (TTT)

19221 CASCADE FRAGMENTATION MODEL. F. P. Denisov. Tr. Fiz. Inst., Akad. Nauk SSSR, 22: 129-54 (1964). (In Russian)

In the cascade model the nucleons within a nucleus are considered to be bound in several groups which are continually forming and dissociating. The group lifetime is on the order of R/v, where R is the radius of the nucleus and v is the average nucleon velocity. The cascade lifetime is on the order of R/v_0, where v_0 is the velocity of the bombarding particle. For bombarding energies up to 1 Bev, $R/v_0 < R/v$, and the distribution of emitted particles (cascade fragments) depend on the group of configuration at the time the bombarding particle entered the nucleus. The groups are each treated as classical particles. The probability that a given group would be expelled from the nucleus was determined for a nucleus with A = 95 ($R = 6 \times 10^{-13}$ cm) by Monte Carlo calculations. Other parameters were determined by probability theory. The probability that a fragment will be recaptured by the residual nucleus is calculated from the liquid drop model. Most of the fragments come from groups which are 5 to 6×10^{-13} cm from the center of the nucleus. The energy distribution of the fragments is only slightly dependent on the distribution of the nucleon groups. The angular distribution decreases rapidly from $\theta = 0$ to 180° for bombarding protons at 660 Mev. The probability of fragmentation is calculated as a function of the number of fragments N_f, and has a maximum at $N_f = 6$. The emission of a fragment with Z = 2 is 5-20 times more probable than the emission of a fragment with Z = 12. The energy dependence of the total fragmentation cross section is also determined. The results of all of the calculations agree with experimental data. The most probable number of nucleon groups in the nucleus appears to be 2. (TTT)

19222 INVESTIGATION OF ENERGETIC PARTICLE FORMATION, WITH M > M_p, EMITTED DURING 7.5 Bev π-MESON INTERACTIONS WITH PHOTOEMULSION NUCLEI. G. A. Tleubergenova, T. P. Lazareva, and P. V. Morozova Vestn. Akad. Nauk Kaz. SSR, No 10, 35-44(Oct. 1964). (In Russian)

Interactions of 7.5-Bev pions in NIKFI-R nuclear emulsions were studied on the Dubna synchrophasotron. Angular and energy distributions and cross sections of deuterons, tritons, and alpha particles emitted with kinetic energies above 25 Mev/nucleon were analyzed. Particles stopped in the emulsion were identified using the g^*-$p\beta$ dependence and the mean scattering of particle-track ends. For particles not stopped in the emulsion, the g^*-$p\beta$ dependence was determined with g^* being measured along the whole track length. Particle charge was determined from the δ-electron number, from the N_δ^*-$p\beta$ curve. In stars with radiation numbers $N_h \geq 2{,}240$ deuterons and tritons and 61 doubly-charged particles were found with energies above 25 Mev. The distribution of these stars is presented graphically according to gray and black tracks. It is concluded that the d-, t-, and α-emitting stars are alike and differ considerably from general star distributions not containing tracks of fast particles with M > M_p. Curves are given of relative distributions of stars formed from energetic particles with M > M_p. Angular and energy distributions of the particles with M > M_p agree with each other other very well, indicating a similarity in the mechanism of complex-nucleon-group formation by nuclear splitting. Cross sections are tabulated for energies ≥ 25 and 50 Mev. (ATD)

19223 SEPARABLE NONLOCAL CENTRAL POTENTIAL AND THE BINDING ENERGIES OF LIGHT NUCLEI. Chi-jen Chang and Chi Sun (Peking Univ.). Wu Li Hsueh Pao, 20: 1278-83(Dec. 1964). (In Chinese)

The binding energies of the triton and helium nuclei are calculated with a separable nonlocal central potential. The results of calculation show that, with the parameters determined from low-energy scattering data, such potentials give too large binding energies for three-and four-body systems. Change of the shape of the potential well does not improve the results. (auth)

19224 NEUTRON SCATTERING FROM Au, Hg, AND Tl. J. A. M. de Villiers, C. A. Engelbrecht, W. G. Vonach, and A. B. Smith (South African Atomic Energy Board, Pretoria and Argonne National Lab., Ill.). Z. Physik, 183: 323-40 (1965).

The elastic and the inelastic scattering of fast neutrons from Au, Hg, and Tl was studied at incident neutron energy intervals of ~50 kev from 0.3 to 1.5 Mev. The differential elastic scattering cross sections were determined approximately every fifteen degrees from 20 to 145 degrees. The cross sections for the inelastic excitation of states in Au at 77, 270, 409, 520, 540, 740, 830, 940, 1120, and 1220 kev; in Hg at 160, 208, 440, 610, 980, and 1120 kev; and in Tl at 205, 279, 615, 680, 930, and 1080 kev were determined. The measured elastic scattering cross sections were compared with the results of optical model calculations, and evidence for a decrease in the imaginary part of the potential near the doubly closed shell at A = 208 was observed. The results of Hauser-Feshbach calculations, utilizing known spin and parity assignments together with those estimated from nuclear systematics, were in qualitative agreement with the measured inelastic excitation functions. The effect of resonance width fluctuations was considered in the context of the experimental results. (auth)

19225 EXCITED ENERGY LEVELS IN U^{235}. F. Horsch (Kernforschungszentrum, Karlsruhe, Ger.). Z. Physik, 183: 352-74(1965).

The transitions and levels in ^{235}U populated by ^{239}Pu alpha decay were studied by alpha fine-structure investigations, alpha-gamma and gamma-gamma coincidence measurements. The spectra revealed the existence of at least 17 alpha groups and 24 gamma transitions which could be accounted for by 21 excited levels in ^{235}U. The results are discussed within the framework of the unified model. The proposed level scheme exhibits a level density about twice as high as predicted by the Nilsson theory. This result is in fair agreement with the predictions of the superfluid model of Solov'ev. (auth)

19226 ON THE HYPERFINE STRUCTURE OF THE 6 $^2P_{\frac{3}{2}}$ LEVELS OF ^{87}Rb. G. zu Putlitz and A. Schenck (Universität, Heidelberg). Z. Physik, 183: 428-30(1965). (In German)

The hyperfine structure of the 6 $^2P_{\frac{3}{2}}$ state of ^{87}Rb was investigated with optical double resonance in zero magnetic field. The results for the hfs-splitting constants are A(6 $^2P_{\frac{3}{2}}$, ^{87}Rb) = 27.70(2) Mc and B(6 $^2P_{\frac{3}{2}}$, ^{87}Rb) = 3.94(4) Mc. From these constants one obtains a value for the nuclear quadrupole moment uncorrected for shielding effects of $Q = +0.138(1) \times 10^{-24}$ cm^2. (auth)

19227 NUCLEAR THEORY. Pairing Force Correlations and Collective Motion. A. M. Lane. Frontiers in Physics. A Lecture Note and Reprint Series. New York, W. A. Benjamin, Inc., 1964. 259p. $9.00 (cloth edition); $4.95 (paperback).

A systematic review of the theories of pairing and collective effects is given. Pairing effects, applicable to the intrinsic nature of nuclear motion, are treated, leading from simple models to the quasiparticle concept. Phenomenological attempts to describe collective effects are surveyed, and the detailed theory of collective effects, based on the random phase approximation and introducing the idea of quasibosons, is developed. Application of the theories to experimental data is discussed. 139 references. (M.J.T.)

19228 NUCLEAR MAGNETIC RELAXATION. A Reprint Volume. N. Bloembergen. Frontiers in Physics. A

Lecture Note and Reprint Series. New York, W. A. Benjamin, Inc., 1961. 189p. $8.00.

The thesis on nuclear magnetic relaxation (Leiden, 1948) and the paper "On the interaction of Nuclear Spins in a Crystalline Lattice" (Physica, 15, 386-426) are reprinted, and some comments on major corrections are given. The theory of NMR is discussed in the thesis. The method used for experiments on relaxation time and line width is described, and the experimental results are discussed in terms of the theory. Relaxation by quadrupole coupling is considered. The second paper describes experimental and theoretical investigations of the exchange of energy between a system of nuclear spins in a magnetic field and the lattice vibrations of insulating crystals, studied by NMR absorption. 124 references. (M.J.T.)

Plasma Physics and Thermonuclear Processes

Refer also to abstracts 18525, 18740, and 18902.

19229 (AD-274249) STUDY IN COLLISION PROCESSES IN GASEOUS PLASMAS. Semi-annual Technical Report No. 2. H. J. Oskam, ed. (Minnesota Univ., Minneapolis. Plasma Physics Lab.). Nov. 1964. Contract Nonr-710(37). 15p.

Studies are reported of collision processes in gaseous plasma. The studies include simultaneous light-emission, absorption, and mass-analysis techniques; simultaneous electron and ion density measuring techniques; molecular ion studies; and measurement of ion mobilities with simultaneous identification of the type of ion involved. (T.F.H.)

19230 (AD-609186) ISOTOPIC ABUNDANCE STUDIES OF HOMONUCLEAR AND HETERONUCLEAR MOLECULAR IONS IN RARE-GAS PLASMAS. Technical Report No. 5. M. A. Mosharrafa and H. J. Oskam (Minnesota Univ., Minneapolis. Dept. of Electrical Engineering). Oct. 1964. Contract Nonr-710(37). 110p. $4.00 CFSTI.

A theoretical and experimental analysis is carried out of the molecular ion densities in plasmas formed of rare gases and their mixtures. The molecular ions are identified by use of a quadrupole mass spectrometer and isotopic-abundance analyses. (T.F.H.)

19231 (CEA-R-2623) LA SONDE PYROMETRIQUE (DIAGNOSTIC DE PLASMA). (The Pyrometric Probe (Plasma Diagnosis)). Richard Geller (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Oct. 1964. 11p. Dep.(mn).

When a thermally isolated tungsten wire is bombarded by energetic particles it becomes hot and radiates. Its equilibrium temperature, measured by means of a pyrometer, is such that the input flux power is balanced by the radiation losses. Knowing the temperature of the tungsten, the radiation losses are deduced and assuming a given efficiency for the heat transfer from the particles to the wire, the energy flux of a plasma can be determined. (auth)

19232 (COO-1233-18) THERMONUCLEAR PLASMA STUDIES. Quarterly Status Report No. 7. (Wisconsin Univ., Madison). Oct. 31, 1964. Contract AT(11-1)-1233. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Measurements of octupole particle loss are reported. The results emphasize that any time one employs a specialized velocity distribution, which is not randomized, in order to inject particles into a confining region, it is very likely that until randomization occurs, the monisotropic components of the plasma can be expected to emerge again from the confining region. (C.E.S.)

19233 (GA-6106) MEASUREMENTS OF THE ELECTRON DIFFUSION COEFFICIENT ACROSS A MAGNETIC FIELD. F. Schwirzke and G. H. Eggers (General Atomic, San Diego, Calif.). Feb. 3, 1965. 12p. (CONF-641108-10)

From American Physical Society, New York.

The effective diffusion coefficient across the magnetic field, measured from density profiles, is expected to be that of the ions when the short-circuit effect occurs at the end walls. In addition, the transport coefficient of the electrons can be determined from electron temperature profiles. Since no external electric field is applied in the metallic vacuum chamber, the electrons cannot gain energy while diffusing and gradually cool by collisions with cold neutrals. Direct probe measurements of this decreasing T_e confirm previous assumptions of an anomalous electron transport coefficient which is of the same order as the ion transport coefficient. Though the electrons move much faster than expected from collisional diffusion, the analysis of the density profiles supports the validity of the $1/B^2$ dependence of the ion mobility term, $nv_\perp^i = n\mu_\perp^i E_\perp$. The $E_\perp$ is caused by the electron temperature gradient. The plasma potential is controlled by the potential drop over the sheath in front of the grounded end walls and decreases proportionately to T_e. (auth)

19234 (IPP-1/20) UNTERSUCHUNG DER HARTEN RONTGENSTRAHLUNG AM THETA-PINCH. (Investigation of the Hard X Radiation in the Theta Pinch). E. Barbian (Institut fur Plasmaphysik, G.m.b.H., Garching, (West Germany)). Jan. 1964. 52p.

The emission of hard x radiation in theta pinch discharges was explained as bremsstrahlung of free accelerated electrons released at the wall. Assumption for a free acceleration is both a weak interaction with neutral gas and also the weak interaction with other charge carriers at low charge carrier density before the ignition. The investigation of the hard x radiation was extended over several magnetic half waves before the ignition. The x emission in its characteristic pattern during the half wave is determined from the configuration of the electric field combined from the potential field and rotation field. The effect of the potential field on the field configuration varies with the charge carrier density increasing at the beginning of each half wave. Three characteristic cases with the present configuration of the electric field can be brought into correlation: the emission beginning after the magnetic field maximum in pure vacuum field configuration, emission beginning before the magnetic field maximum in a field configuration that considers a discharge from the vessel wall, and emission lasting during the complete half wave without introduction of the potential field. The investigation of the local emission of the x radiation shows the effect of the electric potential field of the coil on the drift motion of electrons at the vessel wall. From the time pattern of the x-ray emission the field configuration prevailing in the half wave can be determined. In the hardness measurement of the x radiation with Cu absorbers the experimental results were compared with the theoretically expected absorption behavior. The hardness measurement from the all region of the coil center, together with such measurements outside the coil, show the effect of the magnetic mirror on the electron loss in the coil exterior space. (tr-auth)

19235 (IPP-1/22) SPEKTROSKPOISCHE MESSUNG DER ELEKTRONENDICHTE UND TEMPERATUR BEI VORENTLADUNGSPLASMEN FUR THETAPINCHE. (Spectroscopic Measurement of the Electron Density and Temperature in Pre-Discharge Plasmas for Theta Pinches). Peter-Michael Asam (Institut fur Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1964. 72p. Dep.(mn).

The state of gases that arise in a device for the fast magnetic compression of plasma before the introduction of the principal discharge was investigated with the aid of spectroscopic methods. In this phase, the gas was first ionized by a pulsed electrodeless ring discharge and secondly with a long Z pinch. The knowledge of the characteristic data of the thus pre-ionized gas is essential for the evaluation of the measurements carried out on the principal discharge. The observations were made on a deuterium plasma with initial pressures of 1×10^{-2}, 5×10^{-2}, 6.5×10^{-2}, 8×10^{-2}, 1×10^{-1}, 2×10^{-1}, and 6×10^{-1} torr. In the theta pinch the time of the ignition, the value for the electron density, and the plasma temperature were of interest. The time pattern of the temperature was determined from the quotients of the D_β line intensity to the continuum intensity of a selected

wave length range. The temperature values found lie between $1 \leq kT \leq 3$ ev. The method assumes the validity of the Saha equation for the ionization equilibrium. The time pattern of the electron density was determined first from the photoelectrically measured line width of D_β and then from the absolute continuum intensity of a wave length region free from impurities. The values found show, within the measurement error, a good agreement. The maximum of 2×10^{16} cm^{-3} was attained at the initial pressure $p = 5 \times 10^{-2}$ torr on the axis 3.5 μsec after the ignition of the discharge. At this time point, the discharge battery is however damped approximately at 1/e. The pattern of the electron density represents the plasma configuration found through Trommel camera pictures. The values of the electron density and temperature in long Z pinch, which was determined by the methods selected above, gave, because of their limited spatial resolution, only reference points on the order of magnitude of the electron densities and temperatures to be expected. Therefore, because of measurement technical grounds, an electron density determination is not possible from the half-value width of the D_β line. (tr-auth)

19236 (IPP-1/23) TABELLEN ZUR AUSWERTUNG VON INTENSITATS-MESSUNGEN AN WASSERSTOFF-PLASMEN. (Tables for the Evaluation of Intensity Measurements on Hydrogen Plasma). A. Eberhagen and W. Luenow (Institut fur Plasmaphysik, G.m.b.H., Garching (West Germany)). June 1964. 123p.

A series of functions necessary for the determination of plasma parameters from the radiation emitted were calculated. A brief explanation of the functions cataloged and an indication of the units selected introduce the individual tables. The functions given are the carbon crater continuum, Debye radius, mean particle distance, depression of the ionization work for hydrogen, partial function for hydrogen, Saha function for hydrogen, electron and neutral particle density for hydrogen, line intensities of H_α, H_β, H_γ, and H_δ, intensity of the H^- continuum, intensity of the H continuum, intensity of the total H continuum, quotient of the intensities of the H^- continuum to the H continuum, quotient of the intensities of the total H continuum at λ_1 = 3550 Å to λ_2 = 4526 Å, and quotients of the total H continuum at λ_1 = 3550 Å and λ_2 = 4526 Å to H_α and H_β. (J.S.R.)

19237 (IPP-1/27) BEOBACHTUNGEN UBER MAKROINSTABILITATEN IN EINEM THETAPINCH MIT ANTIPARALLEL EINGEFANGENEM MAGNETFELD. (Observations on Macroinstabilities in a Theta Pinch With Antiparallel Captured Magnetic Field). A. Eberhagen and H. Glaser (Institut fur Plasmaphysik, G.m.b.H., Garching (West Germany)). July 1964. 21p. Dep.(mn).

The triggers for macrostabilities in a theta pinch with antiparallel captured magnetic field and possible ways of excluding them experimentally were investigated. The discharge coils used were described. Studies were made with discharge vessels with probe traps, discharge vessels with probe supports, and polished discharge vessels, all of which are described. The improvement of the macroscopic stability of the plasma column by purification discharge in hydrogen, by purification discharge in helium, and the artificial forcing of the macroinstabilities was investigated. Comparisons were made between the experimentally observed times up to the breaking up of the plasma columns in individual rings and their number on the one hand and the corresponding theoretical assumptions on the other hand. (J.S.R.)

19238 (IPP-1/31) NUMERISCHE BERECHNUNG DES VAKUUM-MAGNETFELDES IN THETA-PINCH-SPULEN UND VERWANDTEN ANORDNUNGEN. (Numerical Calculation of the Vacuum Magnetic Field in Theta Pinch Coils and Related Configurations). F. Pohl and H. Herold (Institut für Plasmaphysik, G.m.b.H., Garching, (West Germany)). Nov. 1964. 30p. Dep.(mn).

The vacuum magnetic field in theta pinch coils with an observation slot perpendicular to the coil axis is calculated numerically. The current distribution in the coil, necessary for the calculation is obtained from the mutual inductances of partial regions along the coil. Only azimuthal surface currents are regarded, including the currents on the end surfaces. Field distributions are presented for the regions of non-vanishing field gradients. The value of B_r on the axes of the coil is described by approximation formulas. Current distribution and field components are calculated for two single-turn coils separated by a slot, for the cases that one coil is shorted or that the applied voltage is opposite at the two coils (cusp-device). (auth)

19239 (IPP-2/19) EIN VERSUCH ZUR KLARUNG DES LANGMUIR-PARADOXONS. (An Attempt at Clarification of the Langmuir Paradox). Werner Ott (Institut fur Plasmaphysik, G.m.b.H., Garching, (West Germany)). Mar. 1963. 31p. Dep.(mn).

The Langmuir paradox consists of the following. Since the walls extract fast electrons leaving the plasma, Langmuir expected for the energy distribution of electrons in the radial direction a significant impoverishment at higher energies. Langmuir's probe measurements in the positive column of low pressure discharges gave, however, on the axis a Maxwell distribution up to energies that are significantly over the wall potential. He could not give a clarification for this finding and assumed the effect of an unknown mechanism. Gabor attempted to explain the brief relaxation gap with the help of high-frequency boundary layer oscillations that should cause mutually an intensive energy exchange of the electrons. The assumption of the general existence of such oscillations is not permanent and an explanation of the Langmuir paradox must be sought elsewhere. It was shown in this study that the scattering of fast drift electrons in the radial direction yields sufficiently short relaxation gaps to satisfy the experimental results. (tr-auth)

19240 (IPP-2/31) ON STELLARATOR "PUMP-OUT." N. D'Angelo (Institut für Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1963. 8p. Dep.(mn).

An instability is postulated that could give rise to quasi-electrostatic ion waves propagating across magnetic field lines in fully ionized stellarator plasma. The mechanism does not require a relative drift between electrons and ions along the magnetic field lines. The growth rate of the oscillations produced appears to be fast enough to account for the observed enhanced diffusion ("pump-out") of the plasma across the magnetic field in stellarator plasma. (T.F.H.)

19241 (IPP-2/34) STUDIEN ZUR STATISCHEN SCHICHT. (Studies on Static Layer). W. Ott (Institut fur Plasmaphysik, G.m.b.H., Garching (West Germany)). Jan. 1964. 43p. Dep.(mn).

Intrinsic and independent measurements of the electric field strength of the plasma boundary layer were compared with an approximation calculation on the basis of the Bohm criterium and with exact solutions of the plasma layer equation of Tonks and Langmuir for the range of the layer. In all calculations, a level S form appears for the pattern of the field strength and therefore, in a wide range of the currentless layer, an approximately linear pattern, which agrees well with the experimentally found almost linear rise. The linear extrapolation of the linear part of the experimental curve to field strength zero or the point of intersection of the tangent to the reversing point with the abscissa permits the definition of a layer thickness, that should be called optical for two reasons: first, because the form of the field strength curve gives this definition and, second, because the layer thickness thus defined agrees with optical measurements of Langmuir and Mott-Smith. (tr-auth)

19242 (IPP-6/30) PLASMADIAGNOSTIK DURCH NICHTLINEARE RESONANZWINKELSTREUUNG. (Plasma Diagnostics by Nonlinear Resonant-Angle Scattering). A. Salat and A. Schlueter (Institut für Plasmaphysik, G.m.b.H., Garching (West Germany)). Dec. 1964. 16p. Dep.(mn).

Nonlinear scattered light with twice the frequency of the incident beam is in phase with the mechanism by which it is produced for some particular angle of emission, and

hence has a resonant character in that direction. The angle is a function of the electron density in the plasma. The intensity and the angular width of the resonant beam are discussed. The experimental application to present laboratory plasmas may be practicable, when strong lasers are developed in the infrared region. (auth)

19243 (LA-DC-6352) CONVERGENT PLASMA TEST PARTICLE PROBLEM. C. W. Hirt (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1962]. Contract [W-7405-eng-36]. 27p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A charged test particle passing through an electron plasma is subject to a drag force. Previous calculations of this drag force, when the test particle's velocity is maintained at a constant value, have led to logarithmically divergent results. A convergent and consistent expression is derived for the drag using a modified linearization of the Vlasov equation. (auth)

19244 (LA-DC-6353) CONVERGENT ELECTRON PLASMA KINETIC EQUATION. C. W. Hirt (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1962]. Contract [W-7405-eng-36]. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A convergent and consistent kinetic equation is derived for a spatially homogeneous electron plasma using a modified expansion of the B-B-G-K-Y hierarchy equations. (auth)

19245 (LGI-64/2) ON RELATIVISTIC PLASMA OSCILLATIONS. F. Santini and G. Szamosi (Laboratorio Gas Ionizzati, Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Jan. 1964. 14p. Dep.(mn).

Solutions are presented to the initial-value problem of the relativistic linearized Boltzmann-Vlasov equation. Exact solutions are presented for the longitudinal-oscillation problem. The relativistic Maxwellian equilibrium distribution function is studied. Dispersion relations are found for both transverse and longitudinal oscillations, for a relativistic Maxwellian distribution function, in the extreme relativistic limit. In this calculation, the oscillations are found to be stable and undamped. The case in which the equilibrium distribution consists of two streams is discussed shortly. Quantum effects are neglected throughout. (T.F.H.)

19246 (MATT-328) "ENHANCED" PLASMA LOSSES IN A Q-DEVICE. S. v. Goeler and N. D'Angelo (Princeton Univ., N. J. Plasma Physics Lab.). Jan. 1965. Contract AT(30-1)-1238. 7p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The Cs plasma density in the Q-3 plasma device is measured, with the plasma column partially surrounded by a stainless steel tube. The plasma density variations with the tube bias and with the magnetic field are studied by the use of phenomenological equations. (T.F.H.)

19247 (ML-TDR-64-317) PRELIMINARY STUDY OF A RADIO-FREQUENCY PLASMA. Paul J. Huffman and Edmund J. Rolinski (Air Force Materials Lab., Wright-Patterson AFB, Ohio). Sept. 1964. 21p.

A radio-frequency discharge in an argon plasma operating at one atmosphere was studied. The operating parameters of the plasma, such as oscillator frequency, arc configuration, and argon flow rate, were determined. The properties of the radio-frequency discharge, such as degree of ionization, temperature, shape of discharge, intensity, acoustical fluctuations, and penetration of discharge (skin depth), were determined. (auth)

19248 (MPI-PAE/P1/1/65) BESTIMMUNG DER M + S-SPULENFORM DURCH EIN ANALOGEXPERIMENT. (Determination of the M + S-Coil-Configuration by Means of an Analogous Experiment). H. Bialas (Max-Planck-Institut für Physik und Astrophysik, Munich (West Germany)). Jan. 1965. 27p. Dep.(mn).

In a high-frequency analogous model in which the plasma is simulated by a copper-form representing a M + S-surface that coil-shape which produces a constant magnetic field on the M + S-surface was determined. In the elaborated optimal configuration the field on the M + S-surface is constant within $\pm(1.4 \pm 0.3)\%$. For a plasma with equal volume but constant cross section in a normal torus the field decay is $\pm 4.2\%$. The drift time of a plasma in the elaborated configuration is accordingly prolonged by a factor $\sqrt{(4.2/1.4 \pm 0.3)} = 1.8 \pm 0.2$. It seems to be possible to reduce the field deviation to $\pm 0.25\%$ by improving the technique of measuring. The drift time is then prolonged by a factor $\sqrt{(4.2/0.25)} \approx 4$. (auth)

19249 (NASA-TN-D-2716) EXPANSION OF THE FOKKER-PLANCK EQUATION IN SPHERICAL HARMONICS. Frederic A. Lyman (Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio). Mar. 1965. 35p. $2.00(CFSTI).

The first two terms in the general spherical harmonics expansion of the Fokker-Planck equation are derived by a simplified method. Some remarks are made on the feasibility of obtaining the general term of the expansion. Errors in previously published results are pointed out. (auth)

19250 (NASA-TN-D-2717) EXPERIMENTS ON INDUCTIVE AND CAPACITIVE RADIOFREQUENCY HEATING OF A HYDROGEN PLASMA IN A MAGNETIC FIELD. Clyde C. Swett (Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio). Mar. 1965. 18p. $1.00(CFSTI).

Experimental results for heating a plasma by a radio-frequency (r-f) coil having an ungrounded electrostatic shield are analyzed by using an electric-circuit model based mainly on the geometric character of the apparatus. This model indicates that the presence of a plasma adds a "lossy" capacitor in parallel with the r-f coil. Consequently, power goes into the plasma both inductively and electrostatically. It is believed that the electrostatic mode of power transfer is responsible for some anomalies noted in plasma experiments. The amount of power in each mode was calculated and shown to vary with magnetic field. The inductive power transfer increased at magnetic-field values near the atomic and molecular ion cyclotron fields, whereas the electrostatic power decreased or increased depending on which parameter—power or coil voltage—was held constant. Maximum total power transfer was as high as 90 percent of the input power and occurred near the atomic and molecular ion cyclotron resonance fields. The electron-density decrease noted near the resonant points appeared to be related to the induction mode only. Some deficiencies of this simple model are noted, and the importance of accurate measurements in this type of analysis is indicated. (auth)

19251 (NP-14689) RAZRABOTKA APPARATURU DLYA ISSLEDOVANIYA VYSOKOTEMPERATURNOI PLAZMY PO PRONIKAYUSHCHIM IZLUCHENIYAM. (Development of Apparatus for Examination of a High-Temperature Plasma by Means of Penetrating Radiation). S. A. Baldin, V. V. Matveev, A. M. Radyvanyuk, and A. D. Sokolov (Gosudarstvennyi Komitet po Ispol'Zovaniyu Atomnoi Energii SSSR). [1963]. 24p. Dep.(mn).

Problems encountered in developing electronic instrumentation for diagnostics of high-temperatures plasma by means of recording and spectrometry of strong x-ray and neutron emissions are discussed. Tests were made with Tokamak-1 and Tokamak-2 toroidal strong magnetic field installations. The neutron emission formed in d(d, ^{3}He)n and d(t,^{4}He)n reactions was used for determining the intensity of nuclear reactions, ion temperature and acceleration processes taking place in the discharge. The bremsstrahlung resulting from electron interactions with plasma ions, electrons, and walls of the lines was used to obtain the data on the stability of plasma, the influence of electrons on the discharge course, and the distribution of magnetic lines in the magnetic field. (R.V.J.)

19252 (NP-14717) OB ABSOLUTNOM IZMERENII ELECTRONNOI PLOTNOSTI REZONATORNYM METODOM. (Absolute Measurement of Electron Density by a Resonator Method). B. I. Ivanov (Gosudarstvennyĭ Komitet po Ispol' zovaniyu Atomnoĭ Energii SSSR). 1963. 9p. Dep.(mn).

Comparisons were made of two methods for measuring the electron density in an electron beam. The first method,

based on resonator field perturbations, gave about 50% higher electron density than the other method, which was based on current density measurements. (tr-auth)

19253 (NP-14725) APERIODICHESKII CHASTOTNYI DISKRIMINATOR S POLOSOI PREOBRAZOVANIYA DO 25 Mc/c. (An Aperiodic Frequency Discriminator with Conversion Band Up to 25 Mc/s). S. S. Petrusev and S. D. Il'in (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoĭ Energii SSSR). 1963. 12p. Dep.(mn).

Design and performance of an aperiodic frequency discriminator with a conversion band up to 25 Mc and strongly fluctuating signal of 20 db is described. The discriminator is used for plasma diagnostics and is based on the Doppler effect. The parameters of the developed amplifier converter are as follows: the sensitivity-10 mv, speed of response about 1 μsec, amplitude spectrum construction from 20 to 1.4 db, frequency recording range 25 Mc, and nonlinearity of the continuous frequency characteristics of 20%. (R.V.J.)

19254 (NP-14820) SYNCHROTRON RADIATION MEASUREMENTS FROM A HOT ELECTRON PLASMA. Report No. 64-28. A. J. Lichtenberg, S. Seisnic, and A. W. Trivelpiece (California Univ., Berkeley. Electronics Research Lab.). Aug. 17, 1964. Contracts NSF-GP-2239; AF-AFOSR-139-64; and AF33(615)-1078. 7p.

The synchrotron radiation emanating from a hot-electron plasma produced in a pulsed magnetic mirror field has been measured. The measurements were made with a 1-μsec time-constant InSb detector with a frequency response covering the wavelengths between 4 and 0.1 mm. For peak fields between 30 and 60 kG, with corresponding electron temperatures between 25 and 50 kev, the radiation was found to be greater than 0.1 mw/ster at the low field and greater than 1.0 mw/ster at the high field. This variation was consistent with that calculated by integrating the radiation from a single electron over a two-dimensional relativistic Maxwellian with the appropriate temperature. The calculation, together with the measurement radiation amplitude, was used to determine the total number of radiating electrons ($N = 10^{11}$ electrons). Preliminary results on the spectral distribution of the radiation have also been obtained. The decay of the radiated power is closely correlated with microwave radiation and other diagnostics both in regimes in which the plasma was stable and those in which the plasma developed an instability. The spectral distribution of the radiation has been measured. An independent time-resolved temperature has been calculated from these measurements, and agrees with that obtained from x-ray pulse-height analysis. (auth)

19255 (NP-14857) MEASUREMENT OF THE DECAY RATE OF A HYDROGEN PLASMA. F. E. Irons and D. D. Millar (Sydney Univ. (Australia). School of Physics). Nov. 1964. 8p. (ER-12). Dep.(mn).

Measurements were made of the electron density and temperature in a decaying hydrogen plasma. Within the observed ranges $3 \times 10^{15} > n_e > 1 \times 10^{15}$ cm^{-3} and $11 \times 10^3 > T_e > 5 \times 10^3$ °K, the measured values of the decay coefficient agree with the calculated values of Bates, Kingston, and McWhirter. (auth)

19256 (NP-14871) WILLS PLASMA PHYSICS DEPARTMENT EIGHTH SIX-MONTHLY PROGRESS REPORT, JULY 1–DECEMBER 31, 1964. (Sydney Univ. (Australia). School of Physics). 9p. Dep.(mn).

Research progress on plasma sources, plasma preparation, measurements of azimuthal magnetic fields at low pressures, $\vec{J} \times \vec{B}$ plasma preparation at 0.1 to 1.0 torr, spectral studies of decaying plasma, microwave studies of pre-ionization and front structure in SUPPER I, Alfvén wave attenuation, current induced instability, interferometry, and laser work is briefly outlined. Research reports issued since the last progress report are tabulated. (C.E.S.)

19257 (R64SD-72) EFFECT OF TURBULENCE INTERMITTENCY ON THE SCATTERING OF ELECTROMAGNETIC WAVES BY UNDERDENSE PLASMAS. K. T. Yen (General Electric Co., King of Prussia, Pa. Space Sciences Lab.). Nov. 1964. Contract AF04(694)-474. 49p.

In hypersonic turbulent wakes, mixing between the turbulent inner wake and the outer inviscid wake gives rise to the intermittency phenomenon. It is shown that electron-density fluctuations of a turbulent nature, in addition to those caused by turbulence, will be produced by the intermittency phenomenon. These additional fluctuations depend on the mean electron-density distribution and Townsend's intermittency δ function. Application of the above consideration to turbulent scattering by underdense plasma was made. In contrast to the conventional theory of scattering, two contributions to the scattering cross section are obtained: The first one arises from the intermittency phenomenon and vanishes if the intermittency is omitted; and the second one is due to fluctuations caused by turbulence. This second contribution also contains the intermittency effect, and reduces to that given by the conventional turbulent scattering theory when the intermittency is not considered. Numerical results for the scattering cross section were obtained by using correlation functions and mean electron-density distribution of the Gaussian form. Based on these results, some characteristics of the scattering cross section such as its aspect-angle and frequency dependence are found to be significantly modified by the intermittency. In addition, the magnitude of the cross section will always be larger if the intermittency effects are considered. This increase can be as high as many orders of magnitude in some cases. (auth)

19258 (UCRL-7677(Rev.I)) ION CYCLOTRON ELECTROSTATIC INSTABILITIES. Laurence S. Hall, Warren Heckrotte, and Terry Kammash (Lawrence Radiation Lab., Univ. of California, Livermore). Dec. 11, 1964. Contract W-7405-eng-48. 76p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

An investigation of the instabilities of longitudinal electrostatic oscillations in an infinite magnetized plasma at or near the ion-cyclotron frequency was made. An approximate mechanical analysis of the coupling of the motion to the electrostatic field oscillations was developed, which provides some degree of physical intuition and guides the more abstract dispersion equation approach used in the succeeding analysis. The possible instabilities arising from the ion motion were classified into two types. Type-A instabilities are characterized by the circumstance that the electrostatic field propagates nearly transversely to the magnetic field and as the analysis shows, by the requirement that the transverse energy distribution must be peaked at other than zero energy. A monotonically decreasing transverse energy distribution is necessarily stable in this instance. Type-B instabilities arise when the oscillating electric field has a significant component along the magnetic field. Because of the effect of ion motion along the magnetic field it is now possible for instabilities to arise when the transverse energy distribution decreases monotonically, unlike Type A. Both of these types of instabilities were examined as to their dependence on the type of coupling to the plasma electrons, and the various instability criteria are stated. In these electron-ion instabilities a central feature is the coupling of the transverse ion motion to the motion of the electrons along field lines. The most rapidly growing modes are those in which electrons move one axial wavelength in one ion cyclotron period. For actual experimental plasmas, this axial wavelength may be too long to be supported in the experimental device. This can put severe restrictions on the occurrence of these particular instabilities. Another class of instabilities are those which arise from a coupling of the ion distribution with itself, the electrons playing a passive role only. Of the several kinds of instabilities of this class discussed, the most important are those which arise from a double distribution of ions; e.g., a cold plasma in the presence of a hot ion plasma. The important feature of these instabilities is that they can occur for very low densities. The relevance of this analysis to several current experimental programs is discussed. (auth)

19259 (UCRL-7983(Rev.I)) ON THE STABILITY OF ELECTROSTATIC OSCILLATIONS IN INHOMOGENEOUS ANISOTROPIC PLASMA. Terry Kammash, Laurence S. Hall, and Warren Heckrotte (Lawrence Radiation Lab.,

Univ. of California, Livermore). Aug. 7, 1964. Contract W-7405-eng-48. 17p. Dep.; $1.00(cy), 1(mn) CFSTI.

Because of its relevance to plasma containment in thermonuclear devices, the stability of longitudinal oscillations in inhomogeneous magnetized plasma has recently become the object of intense investigation. These so-called "universal instabilities" are presumed to be independent of the configuration of the confining magnetic field, and could arise as a result of coupling between the particle's gyrational motion and the drift motion resulting from spatial inhomogeneity in the plasma density and/or temperature. The dispersion equation for electrostatic oscillations in an infinite, collisionless, fully ionized plasma in a uniform magnetic field, is derived, assuming the particles obey a bi-Maxwellian velocity distribution and that the density has a gradient in a direction perpendicular to the magnetic field. Purely growing modes—as in the Rayleigh-Taylor instability—cannot exist in such a plasma. Furthermore, it is found that oscillations with frequency $\omega = (\ell + \eta)\Omega_i$, where Ω_i is the ion cyclotron frequency, ℓ is an integer, and $|\eta| \ll 1$, propagating perpendicular to the magnetic field are stable to lowest order in η. A realistic stability condition is presented and discussed. (auth)

19260 (UCRL-12028) CONTROLLED THERMONUCLEAR RESEARCH SEMIANNUAL REPORT, JANUARY–JUNE 1964. (Lawrence Radiation Lab., Univ. of California, Berkeley and Lawrence Radiation Lab., Univ. of California, Livermore). Contract W-7405-eng-48. 145p. Dep.; $4.00(cy), 3(mn) CFSTI.

Research and development are reported on the Pyrotron program, Astron programs, toroidal confinement, plasma research, plasma physics, and engineering development. Separate abstracts were prepared for the six sections. (J.R.D.)

For abstracts of individual sections see: 19094, 19261, 19262, 19263, 19264, and 19265.

19261 (UCRL-12028(p.5-40)) PRYOTRON (MAGNETIC MIRROR PROGRAM). (Lawrence Radiation Lab., Univ. of California, Berkeley and Lawrence Radiation Lab., Univ. of California, Livermore).

Initial operation of a 12-bar stabilizing system on Alice is reported. Clear indications of a substantial reduction in radial plasma losses and a concomitant increase in plasma density were obtained. Limitations on the bar current prevented a wholly satisfactory test, but the stabilizing effect was clearly demonstrated. Also in the Alice experiments, a much clearer experimental and theoretical picture of the nature of the unstable low-frequency oscillations which occur in the absence of stabilizing fields was obtained. In the Table Top experiment, continued study of hot electron plasmas confined in quadrupole stabilized mirror fields has turned up evidence of a new high-frequency instability. This instability, which is apparently associated with plasma anisotropy, appears in bursts of few microseconds duration. During a burst, an appreciable fraction of the plasma is ejected out the mirrors (none across the field); this is accompanied by intense microwave emission from the plasma at the electron cyclotron frequency. The 2× facility, which replaced the older Toy Top compression experiment, has come into operation. Preliminary operation indicated that plasma conditions roughly equivalent to those in Toy Top can be achieved at half-power levels. In addition, the new facility is equipped with quadrupole stabilizing bars that are of interest in confinement. A program to extend the study of minimum-B fields to other examples, and to begin to investigate other means of stabilization is planned. (J.R.D.)

19262 (UCRL-12028(p.51-66)) LIVERMORE TOROIDAL CONFINEMENT PROGRAM. Dale H. Birdsall, Stirling A. Colgate, Harold P. Furth, Charles W. Hartman, and Richard E. Munger (Lawrence Radiation Lab., Univ. of California, Berkeley and Lawrence Radiation Lab., Livermore).

It was previously reported that in the operation of the Levitron, a fine scale instability beginning at about 200 μsec after the initiation of the 3 msec pulse was observed. This instability was identified as being due to pulsed d-c current flowing along the lines of force. By substituting r-f heating at a frequency of about 5 Mc/sec, the instability does not develop, and the plasma is stably confined for the full duration of the pulse. Because of the deteriorating condition of the Levitron, the machine was completely rebuilt in a simplified form by eliminating the double-wall construction of the vacuum chamber. The long-pulse operation, which proved to be feasible, permits the use of a much heavier vacuum wall than was originally thought to be acceptable. The rebuilt Levitron will have greater flexibility in excitation of the B_θ windings, which is of interest because it was realized recently that, by a proper nonuniform distribution of currents in the toroidal windings producing the $B\theta$ field, some of the features of a maximum $\int dl/B$ configuration can be realized. A bakeable plasma source with an ohmically heated hollow cathode was constructed. Substitution of a hollow cathode for the previously designed ribbon fiament was done to minimize the total gas input. Preliminary operation indicates that the hollow-cathode mode can be attained for inputs of 10^{17} to 10^{18} deuterium atoms. The investigation of surface ionization of Na and Li on Ir was completed. Efficiencies of 90 to 100% were observed for both metals. Iridium and plates will be employed in an experimental apparatus to test the compensating-curvature interchange-stability criterion. The $\int d\ell/B$-stable multipole torus idea has been under development, and much more practical solutions have been found. The present solutions already compare with conventional shear-stabilized configurations in terms of headward feasibility. The Alfvén-wave properties of a plasma nonuniform in one dimension were obtained. Magnetosonic modes are found to carry over with minor modification from the uniform-plasma case. Torsional or principal modes, however, become singular at resonance points within the plasma where $\omega = \overline{k} \cdot \overline{v}_a$. The singularities of the torsional modes lead to spreading of finite wave packets in azimuth, which can explain the cathode-anode asymmetry observed in linear hard-core pinches. Excitation of the internal resonances may also provides a means of heating plasma either ohmically or at ω_{ci}. (J.R.D.)

19263 (UCRL-12028(p.67-80)) BERKELEY PLASMA RESEARCH. (Lawrence Radiation Lab., Univ. of California, Berkeley and Lawrence Radiation Lab., Univ. of California, Livermore).

Improvements in the Homopolar-V vacuum system are reported. Investigations of internal crowbar mechanisms in Homopolar-V revealed that the internal crowbar current passes between the electrodes along magnetic field lines. Experiments with Homopolar Gun I are reported along with investigations of the highly ionized decaying H_2 plasma of Hothouse I. Other work is reported on computer model ion cyclotron resonance experiments and hydromagnetic ionizing ionizing fronts. Sheet pinch studies were devoted to Triax tubular pinch stability. The cylindrical plasma column in this device was observed photographically and magnetically to break up into 12 evenly spaced shreds. Analysis of cross-section measurements at 10 Mev for exciting neutral H atoms was completed. Investigations of electron capture by fast protons, and diffusion of plasma from a hollow-cathode line source are discussed. (J.R.D.)

19264 (UCRL-12028(p.81-120)) THEORETICAL AND BASIC EXPERIMENTAL PLASMA PHYSICS. (Lawrence Radiation Lab., Univ. of California, Berkeley and Lawrence Radiation Lab., Univ. of California, Livermore).

Research is reported on electron injection in the Astron device, stability in inhomogeneous-anisotropic plasmas, exchange variance in magnetohydrodynamics, resistive instability in Triax, formation of Astron E-layer, hydromagnetic equilibria in minimum-B systems, proton-electron correlations in plasma, magnetic shocks, oscillations in relativistic beams, atomic collisions, ion cyclotron electrostatic instabilities, theory of the bumpy torus, stable torus configurations, thermally inhomogeneous plasma columns, wave-particle interactions in plasma, plasma equilibria with finite pressure, electron scattering, and molecular hydrogen ion excitation. (J.R.D.)

19265 (UCRL-12028(p.121-36)) ENGINEERING DEVELOPMENT. (Lawrence Radiation Lab., Univ. of Cali-

fornia, Berkeley and Lawrence Radiation Lab., Univ. of California, Livermore).

Developments are reported on multistate compressors, Alice low-energy neutral beam experiments, cryogenics, Astron auxiliaries, Levitron components, Pyrotron facilities, pinch devices, and apparatus for atomic scattering and cross-section measurements. (J.R.D.)

19266 (FTD-TT-64-1316(p.948-51)) THE INTERACTION OF STREAMS OF RAREFIED PLASMA WITH THE MAGNETIC FIELDS OF OBJECTS IN SPACE. Yu. S. Sigov. Translated from Kosmich. Issled., 2: 948-51 (1964).

The structure of a steady boundary layer separating a rarefied plasma from its confining magnetic field is considered. The entire problem is examined in a relativistic-invariant mode. All quantities are assumed to depend only on a single variable, x. The half space $x < 0$ occupied by plasma is separated by a plane boundary layer from the space $x > 0$ in which the magnetic field H, uniform at $x \to \infty$ and parallel with the axis 0_z, is concentrated. Magnetic field and plasma are in dynamic equilibrium and do not interpenetrate. It is assumed that the free orbit of the particles is considerably larger than the Larmor radius in the H_0 field, and therefore, collisions can be neglected. All electrons and ions with a positive x-impulse component for $x \to -\infty$ rebound from the magnetic wall. The electric current, j, generated at the interface, shields the plasma from the magnetic field, H_0. Plasma polarization caused by the difference between the impulses of positive and negative constituents gives rise to the electric field, E. (ATD)

19267 (RSIC-333) ON THE STEADY STATE OF IONIZATION IN WEAKLY IONIZED PLASMA IN THE NON-EQUILIBRIUM STATE. E. Matsuura. Translated from Denki Shikensho Iho, 27: 491-5(1963). 13p.

The problem of generalizing the Saha formula has been expressed. A simplified model was treated. When the temperature of the electron is greater than that of the neutral atom (the gas temperature), the ionization density increases. Although this model is extremely idealized, it is a possibility of increasing the electric conductivity. Actually, in order to create such a plasma, when the external electrical field is intentionally applied, the problem must be analyzed by using the stationary electron distribution of Druyvestian or of Holstein, and not that of Maxwell. The problem of ionization density and the relaxation phenomenon of a dynamic process in a weakly ionized plasma, unlike the stationary-state ionization, can be discussed in a unified manner since the basic equation pertaining to the electron and the corresponding ion as well as the neutral atom equation can be combined. This problem has already been analyzed macroscopically from the utilitarian standpoint of MHD electrical generation. An attempt is made to obtain the macroscopic equation starting from the basic equation. (auth)

19268 GAS PHASE AND SURFACE PHENOMENA IN SEEDED PLASMAS. Edward E. Zukoski (California Inst. of Tech., Pasadena) and Alfred C. Pinchak. AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 270-6(Feb. 1965).

Some experiments conducted with low-temperature seeded plasmas at atmospheric pressure are discussed. Results of the experiments indicated two modes of steady, stable current conduction between the electrodes. A thermionic process was found to be the mechanism for current emission under all conditions, and the effects of potassium adsorption on electrode surfaces was found to be important. A quantitative comparison between the observed voltage-current characteristics and two current conduction theories is presented. This comparison indicates that both Joule heating and nonequilibrium heating of electrons must be considered in understanding the current conduction phenomena. Electrode heat transfer was also studied, and analysis of the data indicated that an important heat transfer mechanism was the penetration of the surface work function barrier as electrons entered or left the surface. (auth)

19269 NONEQUILIBRIUM ELECTRICAL CONDUCTIVITY MEASUREMENTS IN ARGON AND HELIUM SEEDED PLASMAS. Edward E. Zukoski and Terrill A. Cool (California Inst. of Tech., Pasadena). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 370-1(Feb. 1965).

The electric conductivity of K-seeded Ar and He plasmas was measured as a function of current density, together with relaxation times for the He-K system. A range of seed concentrations less than 1.0 mole % was considered. Results for the Ar-K system at neutral gas temperatures of 1500 and 2000°K and for He-K at 2000°K are compared with theoretical predictions. (D.C.W.)

19270 A MICROWAVE PROBE FOR PLASMA PLUMES. A. J. Kelly (Jet Propulsion Lab., Pasadena, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 372-3(Feb. 1965).

A swinging-arm microwave probe developed for measuring the electron-density profile and effective electron-collision frequency profile transverse to a plasma-jet plume is described. (D.C.W.)

19271 ENERGY PARTITION IN THE CURRENT LAYERS IN PLASMA. Jan Rosciszewski (General Dynamics Astronautics, San Diego, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 373-5(Feb. 1965).

The energy distributions in two types of discharge layers are investigated on the basis of conservation relations across the discharge layer. The magnetic piston, particularly, is considered. (D.C.W.)

19272 QUANTUM THEORY OF ELECTRON GAS PLASMA OSCILLATIONS IN A MAGNETIC FIELD. Norman J. Horing (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.), 31: 1-63(Jan. 1965).

The response function (inverse dielectric function) for an electron gas in an external magnetic field is investigated by the method of Green's functions using the random phase approximation. The spectrum of plasma oscillations, and associated damping, are obtained. In particular, for wave vector p perpendicular to the magnetic field; the dispersion relation is studied as a power series in p^2 and is shown to contain oscillatory terms of the de Haas-van Alphen type in the degenerate case, and quantum dynamical corrections through the parameter $\hbar\omega_c\beta$ in the nondegenerate case. A Mittag-Leffler expansion of this dispersion relation shows that integral multiples of the cyclotron frequency are forbidden, and there are an infinite number of plasma modes (resonances), one in each integral $[n\omega_c,(n+1)\omega_c]$. A semiclassical model is worked through in detail, and the frequencies of these undamped plasma modes are calculated when $p^2[\zeta \text{ or } 1/\beta]/m\omega_c^2 \gg 1$ (low magnetic field). The gaps in the frequency spectrum are calculated. Likewise the excitation amplitudes of the various modes are calculated. "Phase mixing" of the modes (resonances) is considered for small ω_c, and is seen to result in a single damped plasma mode at $\Omega \sim \omega_p$, as one should expect. The dispersion relation for p having arbitrary direction with respect to the magnetic field is studied as a power series in p^2, and again oscillatory terms of the de Haas-van Alphen type are found in the degenerate case. Known nondegenerate results bearing quantum dynamical corrections through the parameter $\hbar\omega_c\beta$ are verified. The semiclassical model is used to calculate angular corrections to the plasma modes (resonances) in the intervals $[n\omega_c, (n+1)\omega_c]$ for small angular departures from the case of perpendicular propagation, $\theta \ll 1$, when $p^2(\zeta \text{ or } 1/\beta)/m\omega_c^2 \gg 1$. The excitation amplitudes of all the plasma modes considered are calculated. Detailed formulas for natural damping, which take full account of the influence of the magnetic field, are given for all the plasma modes considered. These reduce to known results in the nondegenerate case and the field free degenerate case. They show clearly the effects of the field on damping in the degenerate case and the role of oscillatory terms in the de Haas-van Alphen sense is investigated. (auth)

19273 PARTICLE MOTION DISTURBANCES IN A STELLARATOR. A. P. Popryagukhin. At. Energ. (USSR), 18: 96-104(Feb. 1965). (In Russian)

Descriptions are given of conditions in which the small

motion disturbances do not affect the closed trajectories directing charged particles in a stellarator. A linear approximation was developed showing that a toroidal stellarator with a disturbed magnetic field is an absolute trap for individual particles. (tr-auth)

19274 ACOUSTICAL MOTION IN A SEMICONTINUOUS PLASMA. D. G. H. Frood (Royal Armament Research and Development Establishment, Fort Halstead, Kent, Eng.). Can. J. Phys., 43: 476-95(Mar. 1965).

In many plasmas, the electron temperature is so high compared to the ion temperature that the electrons may be treated as a "collisionless" medium. Often, however, the mean free path for the ions is so small that the motion of these particles is dominated by the short-range "collisional" forces. Assuming a hydrodynamical model for the ions and rarefied conditions for the electrons, the linearized collective modes of such semicontinuous plasmas are discussed. The high-frequency oscillations are practically identical with those obtained in the rarefied theory of Frood, but for very long wavelengths the Landau (or electronic) contribution to the optical damping is negligible compared with the viscous (or ionic) damping. Similarly, for the acoustic modes the speed of sound is practically the same as in the rarefied, case, but even at fairly short wavelengths the viscous contribution to the sonic damping outweighs the collisionless contribution. Comparison of the theories of acoustic damping in semicontinuous and rarefied plasma indicates a convenient means of determining to what extent a plasma is behaving in a collision-free or a collision-dominated manner. (auth)

19275 ROLE OF REABSORPTION OF SPECTRAL LINES IN THE IONIZATION PHENOMENA OF HYDROGEN IN A PULSE DISCHARGE. Claude Breton and Jean-Louis Schwob (CEN, Saclay, France). Compt. Rend , 260: 461-4 (Jan. 11, 1965). (In French)

The effect of the reabsorption of the hydrogen lines on transitory phenomena, leading to a totally ionized hydrogen plasma, is studied. A mean transmission coefficient was introduced for each line by taking as a model, as the first stage, an infinite homogeneous cylindrical plasma. The results obtained are compared with those obtained by neglecting reabsorption. (tr-auth)

19276 STUDIES OF DIFFERENCES OF POTENTIAL RESULTING FROM THE INJECTION OF ELECTRONEGATIVE GASES IN A FLAME. Jean Debiesse, Siegfried Klein, and Pierre Kraus (CEN, Saclay, France). Compt. Rend., 260: 465-7(Jan. 11, 1965). (In French)

Two identical electrodes at the same temperature were thrust into a flame, and a potential difference was created between them by injection of an electronegative gas on one of them. This potential difference is a function of the temperature of the electrodes and of the nature of the injected gas. The possibility of obtaining an alternating potential difference was also shown. (tr-auth)

19277 THE TRANSFORMATION OF WAVES IN PLASMA DIELECTRIC INTERFACE. Ts. D. Loladze (Gor'kii State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 985-7(1964). (In Russian)

Following up previous studies on the wave transformation at the boundary of two plasmas, transformations occurring at the boundary between the plasma and a dielectric within an external constant magnetic field were examined for the purpose of clarifying the correlation between the radiation fields and the incident wave. An anisotropic Alfvèn wave, fast and slow magnetoacoustical waves are present in an anisotropic plasma; the wave transformation at the interface is due to their reflection and refraction. Because of the vibration polarization of the waves going to and coming from the dielectric interface, only one type of electromagnetic wave propagates within the dielectric while both the fast and slow waves are reflected in the plasma. The boundary conditions of the continuity of the tangential components of the electric and magnetic fields and of the normal component of the electric field were used to establish the correlation between the amplitudes of the generated and incident waves. By estimating the degree of transformation of the electromagnetic wave in the dielectric under given boundary conditions, the radio of energy fluxes of the diffracted and incident waves may be derived. The transformation occurs only within a narrow-angle cone of incidence. (TTT)

19278 SURFACE WAVES IN GYROTROPIC PLASMA LAYER. I. G. Kondrat'ev. Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 987-91(1964). (In Russian)

Previous work on the surface waves of an anisotropic plasma layer was extended by studying the electromagnetic surface waves in a gyroscopic plasma layer, examining the effect of the magnetic field in the presence of a transverse external field. It was assumed that the plasma is homogeneous, filling the space between the planes $x = x_0$, $x = -x_0$, that the constant magnetic field $H^{(0)}$ is oriented along the y axis, and that the surface wave propagates in the z direction. Formulas were derived on the dielectric penetrability under varying conditions. It is found that under certain conditions "volume" waves appear in addition to the corresponding, clearly "surface" waves. (TTT)

19279 FIELDS PRODUCED BY A CURRENT SOURCE IN A PARTLY IONIZED GAS. B. Samuel Tanenbaum (Case Inst. of Tech., Cleveland). J. Appl. Phys., 36: 1288-90 (Apr. 1965).

A technique is developed for treating each of the waves generated by an arbitrary current source in a partly ionized gas with no steady magnetic field. Starting with Maxwell's equations and three sets of coupled hydrodynamic equations (for the electrons, ions, and neutral molecules), it is shown that one can obtain a separate inhomogeneous wave equation for each type of wave in the plasma, with the source term for the transverse and longitudinal waves dependent, respectively, on the curl and divergence of the current source. (auth)

19280 THE CONSERVATION EQUATIONS FOR A NON-EQUILIBRIUM PLASMA. J. P. Appleton and K. N. C. Bray (Univ. of Southampton, Eng.). J. Fluid Mech., 20: 659-72(Dec. 1964).

The gas dynamic conservation equations for the individual species in a non-equilibrium partially ionized gas mixture are derived. As an example, the conservation equations for the electrons and the overall conservation equations are developed for a three component plasma consisting of electrons, singly-ionized positive ions and neutral atoms. Non-elastic collisions are represented by the collisional-radiative decay mechanism of Bates, Kingston & McWhirter. Maxwellian velocity distributions are assumed, but the electrons are allowed to have a temperature different from the heavier particles and to drift relative to them. Particular attention is given to the electron energy balance equation which differs from that used elsewhere. (auth)

19281 SPECTROSCOPIC MEASUREMENTS OF THE PLASMA FROM A PLASMA GUN. [PART] I. Nobuki Kawashima, Kenji Inoue, Masatoshi Tanaka, and Sigeru Mori (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 72-6(Feb. 1965).

Line broadening of He(I) 4471 Å and He(II) 4686 Å radiated from plasma generated in a coaxial plasma gun was measured by a 340-cm spectrometer. Doppler shift measurements indicated that a plasma blob is accelerated during about 5 μsec from the initiation of gun discharge and leaves the plasma gun, while an unaccelerated plasma remains in the gun throughout the discharge period. Most of the line broadening on the He(II) 4686 Å was due to Doppler broadening, and Stark broadening was negligible. The accelerated plasma from the gun gradually lost the velocity component perpendicular to the axis of the plasma gun as it traveled through the vacuum vessel. (auth)

19282 TURBULENT TEMPERATURE. PART I. Kenji Watanage (Osaka City Univ.). Kakuyugo-Kenkyu, 11: 478-98(Dec. 1963). (In Japanese)

In considering the analogy of turbulence and heat, a new quantity of turbulence, the turbulent temperature is introduced, corresponding to the thermal temperature. A description of the turbulent flow by the average-value equa-

tions rather than the investigation of the turbulence mechanism is attempted. By using the turbulent temperature, the distribution of pressure-flow turbulent velocities is explained for a cylindrical pipe. Comments on the plasma turbulence are also given. (auth)

19283 A NEW METHOD TO MEASURE THE DENSITY OF PLASMA BY USE OF FM OR PM DEMODULATION CIRCUITS. Nobuki Kawashima (Japan Atomic Energy Research Inst., Tokyo). Kakuyugo-Kenkyu, 12: 406-9(May 1964). (In Japanese)

A new method to measure the density of plasma is proposed. The principle is based on the measurement of the dielectric constant (or the impedance) of the plasma by use of f-m or p-m demodulation circuits. As the frequency of the h-f used is fixed during the measurement and the output of the circuit is rectified automatically, most of the difficulties inherent in the h-f measurement can be avoided, so that this method can be used as a density measurement of pulsed discharges. (auth)

19284 DIFFUSION AND LOW-FREQUENCY OSCILLATION OF PLASMA IN A MAGNETIC FIELD. Kiyoshi Yatsui and Uichi Kubo (Osaka Univ.). Kakuyugo-Kenkyu, 12: 510-27(June 1964). (In Japanese)

The diffusion rate of ions in a plasma is studied with respect to a longitudinal magnetic field in the range 0 ~ 1,000 gauss (lower than the critical field for screw instability) from measurement of the diffusion current on the wall of the discharge tube. Compared with the classical ambipolar diffusion theory, a small deviation is found when the magnetic field comes to a certain value. In addition, an oscillation of the plasma in a magnetic field is investigated. These studies indicate that the plasma becomes unstable suddenly to produce low-frequency oscillations at a certain magnetic field where enhancement of the diffusion coefficient appears. It seems to suggest that there is another kind of critical magnetic field for instability under the critical field for screw instability. (auth)

19285 THE PERFORMANCES OF THE PINCH GUN AT OSAKA UNIVERSITY. Keiichi Hirano (Osaka Univ.). Kakuyugo-Kenkyu, 12: 528-55(June 1964). (In Japanese)

A pinch gun of linear type was investigated as the source of a high-energy plasma jet. The gun employs a low inductance (18 mμH) power supply and pulsive admission of gas into vacuum by a fast-acting valve mounted on the bottom copper disk electrode. A sufficiently high speed (~ 10^8 cm/sec) plasma jet of hydrogen gas was obtained when the gas diffusion delay time (t) was short. It was found that the performance of the plasma gun is closely related to the pinch effect taking place in the gun. The ratio H of the plasma speed to the mean pinching speed of the gun depends only on (t) and not on the total amount of admitted gas. The mean pinching speed followed Rosenbluth's theory, was independent of (t) and was a function of average gas density in the gun. For small (t), H is said to be constant about (t) and the starting voltage of the plasma-driving condensers, and decreases suddenly for some critical value of (t), which becomes larger when the starting voltage of the condensers is higher. (auth)

19286 STUDY OF CUSP INJECTION BY A STREAK CAMERA. Kunizo Shinano (Osaka Univ.). Kakuyugo-Kenkyu, 12: 556-63(June 1964). (In Japanese)

Experiments were done to study interactions between high density hydrogen plasmas and magnetic fields. Behaviors of injected plasma were studied using streak photographs taken through a long slit imaged at the axis of the straight vacuum vessel. It was found that in a single coil field, plasma decreases its axial velocity in encountering a strong field, and penetrates through it even when the field strength is more than 8,000 gauss. In a cusped field, after penetrating through the entrance cusp, plasma takes back its original speed and goes through the zero region of the field with this constant velocity up to a certain point at which the velocity changes abruptly. Then plasma moves toward the exit cusp and is reflected by a 6000-gauss field. Plasma injected into a mirror field is not trapped. (auth)

19287 TRANSVERSE PLASMA WAVES IN A MAGNETIC FIELD. Ikuo Kaji (Univ. of Hokkaido, Japan) and Masafumi Kito. Kakuyugo-Kenkyu, 12: 564-72(June 1964). (In Japanese)

A dispersion relation for tranverse plasma waves propagating along a uniform external magnetic field is obtained in the form of an algebraic equation, for an anisotropic velocity distribution: $\{[(\omega/\omega_p)^2 - (kc/\omega_p)^2] \times [(\omega/\omega_p) \pm (\Omega/\omega_p)] - (\omega/\omega_p)\} \times [(\omega/\omega_p) \pm (\omega/\omega_p)] = (1/2)\ (\sigma_1/c)^2\ (kc/\omega_p)^2$, where ω_p is the plasma frequency, Ω the cyclotron frequency, and $\sigma_1^2 = (2\pi T_1/m)$. Within given ranges of variable kc/ω_p and parameters σ_1/c and Ω/ω_p the dispersion relation is solved by the use of the digital computer (HIPAC-103). For the right-handed circularly polarized waves, the dispersion curves are described and the stable regions of tranverse waves are determined for several parameters. The dispersion curves consist of two modes of electromagnetic waves, and of modes of growing and damped waves that oscillate in cyclotron frequency. In the absence of the external magnetic field, the growing waves with cyclotron frequency become spontaneously growing waves as obtained by E. S. Weibel. (auth)

19288 INVESTIGATION ON THE VALIDITY OF PROBE MEASUREMENT OF PLASMA IN MAGNETIC FIELD WITH MICROWAVE METHOD. Uichi Kubo and Yoshio Inuishi (Osaka Univ.). Kakuyugo-Kenkyu, 13: 1-23(July 1964). (In Japanese)

The ion-collecting probe method for measuring the electron density of the steady-state argon plasma (1.0 mmHg) in a magnetic field is investigated. The probe method is checked with the microwave transmission method (34 × 10^{10} c/s), which does not suffer from the effect of the magnetic field. At magnetic field intensities from zero to 30,000 gauss, however, both densities agree fairly well, if the density from the probe measurement is calculated assuming that the electric field of the probe does not penetrate into the plasma and that the drift velocity of the ions in the probe sheath depends on $(E/p_0)^{1/2}$. (auth)

19289 THE MASS SPECTROMETRY OF MULTICOMPONENT PLASMA. Yasuo Suzuki (Tokyo Univ.). Kakuyugo-Kenkyu, 13: 24-34(July 1964). (In Japanese)

The ion components of plasma ejected by a Teflon packing gun are measured with a radial electrostatic energy analyzer in connection with time of flight. (auth)

19290 AN EXPERIMENT OF THE TURBULENT DIFFUSION OF THE MAGNETIZED POSITIVE COLUMN. Kazuo Minami and Shingo Imazu (Tokyo Inst. of Tech.). Kakuyugo-Kenkyu, 13: 53-66(July 1964). (In Japanese)

The stabilization of the magnetized positive column and the decrease of anomalously rapid diffusion is expected by a calculation extended from B. B. Kadomtsev's theory, when the azimuthal component of the electric field is suppressed by using the partially conducting wall. A qualitative agreement is found between the experiment and the theory. The longitudinal electric field measured in the experiment in the case without the conducting wall is also compared with the turbulent diffusion theory given by B. B. Kadomtsev with which it is in good agreement. (auth)

19291 OSCILLATIONS OF A QUANTUM ELECTRON GAS IN A UNIFORM MAGNETIC FIELD. Eric Canel and N. David Mermin (Univ. of Birmingham, Eng.). Lectures Many-Body Probl., 2: 169-77(1964).

A quantum mechanical analysis is given of the behavior of an electron gas in a uniform magnetic field. The results of the analysis in the long-wavelength limit, using the random phase approximation, are presented, giving the location of the resonant frequency, a discussion of the resonance damping, and a semiclassical picture of the collective motions involved. The behavior of the weakly excited higher order cyclotron resonances is considered for cases with strong Landau damping, with perpendicular propagation, and at zero temperature. (M.J.T.)

19292 NUMERICAL INTEGRATION OF KINETIC EQUATIONS. A. Dolinsky (Univ. of Maryland, College Park). Phys. Fluids, 8: 436-43(Mar. 1965).

The problem of the relaxation to a Maxwellian of the Balescu-Lenard equation is solved numerically as an initial value problem for isotropic distributions of electrons situated in a neutralizing, uniformly smeared out back-

ground of positive charge. Several different forms for the initial distribution function are chosen: a Gaussian peaked at about 0.28 of the electron thermal speed, a resonance function, and a Maxwellian coexisting with a sharply peaked Gaussian (the peak of the Gaussian being located at two thermal speeds of electrons). The Fokker-Planck equation with the Rosenbluth-MacDonald-Judd collision term is also solved numerically under the same restrictions and with the same initial distribution functions. Comparison of the solutions of the two kinetic equations shows that the difference between them is very small, and a probable reason for this is advanced. The evolution of the distribution functions with time is studied, and a relaxation time is defined. (auth)

19293 BOUNDS ON PLASMA FLUCTUATIONS AND ANOMALOUS DIFFUSION. T. K. Fowler (Oak Ridge National Lab., Tenn.). Phys. Fluids, 8: 459-70(Mar. 1965) (ORNL-P-15)

Upper limits on the intensity and growth rate of plasma fluctuations are calculated from purely thermodynamic considerations. From these limits, an upper bound on diffusion across a magnetic field by microinstabilities is estimated. Experimental results do not violate the bound. At low β, the dominant contribution to the bound is thermal energy which feeds fluctuations through a mechanism akin to expansion cooling of a gas, possible only in finite plasmas. A rapid decrease in anomalous diffusion in discharge afterglows when the radius R exceeds a critical value $R_0 \sim$ 10–20 ion gyroradii can be explained if the instability radial wavelength, a parameter in the theory, is restricted to $\lesssim R_0$. Then the bound on the stochastic diffusion coefficient decreases like R^{-3} if $R > R_0$. With this restriction on wavelength, the bound used as a scaling law predicts adequately long thermonuclear confinement ($\gtrsim$0.1 sec) in a torus of 100 cm minor radius if the torus is stabilized against frequencies below the ion cyclotron frequency, now perhaps feasible. Otherwise, low-frequency resonant diffusion may limit containment. This result holds at least up to β of a few percent. Bounds on velocity diffusion are obtained, also. Both spatial and velocity diffusion are low if electrons are cold compared to ions, which may account for observations in plasmas created by energetic ion injection. (auth)

19294 FIRST- AND SECOND-ORDER LANDAU DAMPING IN MAXWELLIAN PLASMAS. J. Denavit (Northwestern Univ., Evanston, Ill.). Phys. Fluids, 8: 471-8(Mar. 1965).

Longitudinal electron oscillations in Maxwellian plasmas give a linear (first-order) electric field which is the superposition of damped oscillations. The complex frequency of lowest damping which yields the long time behavior of the solution was determined by Landau and Jackson. The other frequencies, which indicate the time required for the time-asymptotic solution to be reached, are evaluated for arbitrary values of the ratio r = wavelength/Debye length. These frequencies form two strings of isolated points extending to infinity along the diagonals in the lower half frequency plane. The amplitude and phase angle corresponding to each frequency are found for an initial perturbation sinusoidal in space and Maxwellian in velocity. The results show that for $r \geq 10$, the asymptotic solution is very good after the first cycle. Nonlinear (second-order) corrections are evaluated using the method of Montgomery. They give second space harmonics with a damped oscillatory time behavior. The frequencies, amplitudes, and phase angles are explicitly given. For $r \to \infty$ the results match those of the zero temperature solution. (auth)

19295 MICROSCOPIC FLUCTUATIONS AND DIFFUSION COEFFICIENTS OF A NONEQUILIBRIUM PLASMA IN A MAGNETIC FIELD. Jerome Weinstock (National Bureau of Standards, Washington, D. C.). Phys. Fluids, 8: 479-81(Mar. 1965).

A relation is deduced between the electron density correlation function and the parallel and perpendicular diffusion coefficient of a partially ionized nonequilibrium (but homogeneous) plasma in an external magnetic field. This relation is derived in a particularly simple and direct way from within the rigorous framework of microscopic theory by expanding the Fourier transform of the microscopic electron density in terms of semi-invariants. The previous result derived by Ichimaru—by means of hydrodynamic arguments—is seen to be a special case of the present result. (auth)

19296 SPECTROSCOPIC STUDY OF A HIGHLY IONIZED HYDROGEN PLASMA. William S. Cooper, III, and Wulf B. Kunkel (Univ. of California, Berkeley). Phys. Fluids, 8: 482-92(Mar. 1965). (UCRL-11502; UCRL-11502(Rev.))

Experimental details are given for time- and space-resolved determinations of electron temperature and density in a highly ionized, decaying-hydrogen plasma. The technique used involves absolute intensity measurements of the H_β line and of two widely separated portions of the continuum. A carbon arc is used as a radiation standard. The inferred ion density agrees satisfactorily with that deduced from Stark broadening of the H_β line. Internal consistency among various methods of inferring a temperature indicates when and where the technique yields reliable results. It is shown that the plasma ($N_e \approx 4 \times 10^{15}$ cm^{-3}, $T_e \approx 1$ to 2×10^4 °K), which is produced in a long cylinder in a strong axial magnetic field, decays by volume recombination. Diffusion losses appear to be negligible. (auth)

19297 RADIO WAVES IN TURBULENT MAGNETO-PLASMAS. Leonard S. Taylor (Case Inst. of Tech., Cleveland and Centro de Investigacion y de Estudios Avanzados del Instituto Politecnico Nacional, Mexico City). Phys. Fluids, 8: 492-9(Mar. 1965).

The Ewald-Oseen extinction theorem is generalized to account for electromagnetic propagation in a turbulent magneto-ionic medium. Using the Born (single-scatter) approximation, the effective dielectric constant for the medium is determined. The scattered field is derived and a general expression for the second-order term in the Born series for the mean-square amplitude of the scattered field is obtained. (auth)

19298 VERIFICATION OF HOT PLASMA THEORY FOR MICROWAVE PROPAGATION. E. B. Meservey (Princeton Univ., N. J.) and S. P. Schlesinger. Phys. Fluids, 8: 500-6(Mar. 1965). (MATT-265)

An analysis is presented of an experimentally detected resonance at the second harmonic of the electron cyclotron frequency. Phase shift and attenuation measurements show reasonable agreement with the predictions of hot plasma theory. In this theory a dispersion relation is derived from a perturbation solution of the linearized collisionless Boltzmann equation with the velocity distribution function of the unperturbed plasma assumed to be Maxwellian. In the experiment 4-mm microwaves were propagated in the extraordinary mode ($E \perp B_0$) across a highly ionized essentially uniform plasma of 10-cm diameter confined in a highly homogeneous (0.05%) magnetic field in the Model C Stellarator. Conditions existing for the measurements are: $5 \leq T_e \leq 25$ ev; $\omega_p \leq \omega/2$; $10^{-5} \leq \nu_{coll}/\omega < 5 \times 10^{-4}$; $\Omega \cong \omega/2$ (Ω is the electron cyclotron frequency). Under these conditions multiple harmonic anomalies as detected by other investigators were not observed. (auth)

19299 HYDROMAGNETIC WAVES IN A NONUNIFORM CURRENT CARRYING PLASMA COLUMN. G. W. Pneuman (Purdue Univ., Lafayette, Ind.). Phys. Fluids, 8: 507-16(Mar. 1965).

The axially symmetric modes of propagation of hydromagnetic disturbances in a current-carrying plasma column with a nonuniform mass-density distribution are investigated. The current density is assumed to be uniform. The column is surrounded by a vacuum and immersed in a uniform axial magnetic field. In the limit of small discharge current, two uncoupled modes of oscillation can take place. One involves a radial pulsation of the column with associated pressure, density, and temperature fluctuations, while the other is a torsional motion. The torsional mode is not accompanied by fluctuations in the thermodynamic properties. The properties of both the radial and torsional mode such as phase velocity, group velocity, cutoff frequency (radial mode only), and attenuation are discussed in detail. The density gradient in the

plasma is found to appreciably alter the torsional mode producing distortions in the wave fronts and significantly increasing the attenuation. (auth)

19300 PLASMA ROTATION IN A HOLLOW-CATHODE DISCHARGE. David L. Morse (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 8: 516-21(Mar. 1965).

Langmuir probe measurements of the external plasma generated by a hollow-cathode discharge indicate the presence of a flutelike density perturbation, or vane of plasma, rotating with a left-handed sense about the magnetic field. The velocity of rotation is found to be closely related to the Hall drift speed of particles in the measured outward radial electric and axial magnetic fields. Azimuthal electric fields are found whose net effect is to increase the outward radial transport of plasma across the magnetic field. A discussion of this phenomenon in terms of a previously described theory is given. (auth)

19301 LOW-DENSITY THETA PINCH EXPERIMENTS. L. M. Goldman, R. W. Kilb, H. C. Pollock, and J. A. Reynolds (General Electric Research Lab., Schenectady, N. Y.). Phys. Fluids, 8: 522-8(Mar. 1965).

Deuterium plasmas, produced by a theta pinch device, with initial pressure of 0.01 torr, were studied by means of neutron measurements, photography, magnetic probes, pick-up loops, spectroscopy, soft x-ray absorption, and by the introduction of impurity ions. Most of the plasmas were created in the absence of trapped fields. Typical plasma conditions obtained are: $n \sim 10^{16}$ cm^{-3}, $T_e \sim 300$ ev, neutron rates of 10^{12} sec^{-1} and ion energies of several kev. The plasma shows no growing instabilities if no reversed field is present. There is particle loss through the end mirrors, with low-energy ions lost preferentially as in classical mirror confinement. (auth)

19302 CONTROL OF PLASMA DRIFT IN THE THETATRON. J. A. Reynolds, E. E. Aldridge, M. Keilhacker, and G. B. F. Niblett (United Kingdom Atomic Energy Authority, Culham, Berks, Eng.). Phys. Fluids, 8: 529-38 (Mar. 1965). (CLM-P-46)

The linear theta pinch drifts laterally with an acceleration directly proportional to the magnetic field gradient and temperature; for example, a magnetic field gradient of only 1 G in 100 kG causes a 1-kev plasma to drift to the wall of a 10-cm-diam tube in 100 μsecs. Four main sources of magnetic field gradient are proposed and examined experimentally; the coil end, the collector shape, the collector-coil discontinuity, and the plasma influence. The magnetic field gradient may be controlled by sectionalizing the coil at regular intervals, or by a tab between the coil and collector or, more conveniently, by the use of an inductive lens. (auth)

19303 EFFECT OF PLASMA POTENTIAL ON MINIMUM-B STABILITY. T. K. Fowler (Oak Ridge National Lab., Tenn.). Phys. Fluids, 8: 544-6(Mar. 1965). (ORNL-P-519)

Plasma confinement by magnetic mirrors with minimum-B configurations is considered. Effects of the ambipolar electric field expected with mirror confinement because of the difference in ion and electron loss rates by scattering are discussed. (C.E.S.)

19304 HIGH-FREQUENCY ELECTROSTATIC PLASMA INSTABILITY INHERENT TO "LOSS-CONE" PARTICLE DISTRIBUTIONS. M. N. Rosenbluth (General Atomic Div., General Dynamics Corp., San Diego) and R. F. Post. Phys. Fluids, 8: 547-50(Mar. 1965).

It was previously pointed out that anisotropies in velocity space may lead to high frequency electrostatic instabilities in a plasma. The most widely studied model has been that of the two-temperature Maxwellian, for which a sufficient condition for stability is the rather unrestrictive one, $T_\perp/T_\parallel < 2$. It is pointed out that a much wider class of distribution functions can be unstable, in particular, those suitable for confinement in open-ended containment fields (e.g., mirror machines) which are characterized by a loss-cone. The case of an infinite homogeneous plasma in a uniform magnetic is considered. Finite systems and nonlinear effects are also discussed. (C.E.S.)

19305 "UNIVERSAL" INSTABILITIES FROM PLASMA MOMENT EQUATIONS. B. Coppi (Univ. of California, San Diego, La Jolla). Phys. Letters, 14: 172-4(Feb. 1, 1965).

It is shown that a set of moment equations which has reproduced purely hydromagnetic, resistive, and inertial instabilities, also yields universal instabilities which are not due to partial-wave resonances. The effects of collisions, of finite Larmor radius, of magnetic field shear and curvature, macroscopic physical factors determining the various instabilities, and new possible modes are investigated. (L.B.S.)

19306 THE DECAY OF A PLASMA ALONG A MAGNETIC FIELD. J. Polman (Rijksuniversiteit, Groningen, Netherlands). Phys. Letters, 15: 48-9(Mar. 1, 1965).

It is shown that the diffusion of a plasma across a magnetic field can be investigated using the decay of the plasma along the field. The plasma is assumed to be weakly ionized, ionization taking place only in the source, and quasi-neutral. Expressions are obtained for the spatial distribution of the product of electron density and temperature, for the decay length, and for the electron density distribution. Some results of measurements of ion saturation current to probes in a discharge tube are presented. For fields with low induction, the plasma behavior agrees with classical diffusion theory, but above a critical value of the magnetic field, radial diffusion is not reduced by the field. (M.J.T.)

19307 UNSTABLE ELECTROSTATIC PLASMA WAVES PROPAGATING PERPENDICULAR TO A MAGNETIC FIELD. R. A. Dory, G. E. Guest, and E. G. Harris (Oak Ridge National Lab., Tenn.). Phys. Rev. Letters, 14: 131-3(Feb. 1, 1965). (ORNL-P-932)

It is shown that unstable electrostatic waves with $k_\parallel = 0$, where $k_\parallel$ is the component of the wave-propagation vector parallel to the magnetic field, can exist in a homogeneous plasma in a uniform magnetic field. It is also shown that if the distribution of perpendicular speeds is sufficiently broad, the plasma is stable against the $k_\parallel = 0$ waves. (D.C.W.)

19308 ABSORPTION OF ION CYCLOTRON WAVES BY ONE COMPONENT OF A TWO-ION PLASMA. S. Yoshikawa, M. A. Rothman, and R. M. Sinclair (Princeton Univ., N. J.). Phys. Rev. Letters, 14: 214-16(Feb. 15, 1965).

Plasma containing two ion species (H^+ and H_2^+; H^+ and D^+) were produced by ohmic heating in a stellarator, and r-f power was coupled to the plasma. Propagation of waves with subsequent absorption of the wave energy by those ions for which the wave frequency equals the ion cyclotron frequency at some point in the magnetic field was observed. For a plasma consisting of 10% deuterium and 90% hydrogen, the plasma diamagnetism and the neutron production indicate that the minority ions acquire large amounts of energy from the waves. This heating was observed under conditions requiring the waves to propagate through a region of evanescence by "Budden tunneling." (D.C.W.)

19309 EXTERNALLY EXCITED WAVES IN LOW-PRESSURE PLASMA COLUMNS. P. J. Barrett and P. F. Little (Culham Lab., Abingdon, Berks, Eng.). Phys. Rev. Letters, 14: 356-9(Mar. 8, 1965).

Low-frequency waves were excited in the positive column of Ar, H, Hg, and Ne arcs in a longitudinal magnetic field by a coil placed 80 cm from the anode. Backward and forward waves were observed in Ar, Hg, and Ne, while only forward waves were observed in H. The discharge and wave parameters are given. (D.C.W.)

19310 EXISTENCE OF QUASI-STATIC SURFACE AND BACKWARD WAVES IN INHOMOGENEOUS MAGNETO-PLASMA. Pietro de Santis (Polytechnical Inst. of Brooklyn). Proc. IEEE (Inst. Elec. Electron. Engrs.), 53: 192-3 (Feb. 1965).

The conditions for the existence of backward and surface waves in a slab of inhomogeneous plasma in a magnetic field are derived. (D.C.W.)

19311 A RUBY LASER DIAGNOSTIC PLASMA PROBE. David O. Kingsland (General Electric Co., Syracuse, N. Y.).

Proc. IEEE (Inst. Elec. Electron. Engrs.), 53: 196(Feb. 1965).

A technique for determining the electron density and temperature in a plasma is described, using the proportionality of the scattered intensity of a Q-spoiled ruby laser beam (6943 Å) to the number of scatterers and the proportionality of the Doppler shift of the scattering to the thermal velocity of the scatterers. Observations on a helium plasma are discussed. (D.C.W.)

19312 UNSTABLE CYCLOTRON WAVES IN RELATIVISTIC PLASMAS. I. Lerche (Univ. of Manchester, Eng.). Proc. Roy. Soc. (London), Ser. A, 283: 203-15(Jan. 6, 1965).

Linearized equations are set up to describe cyclotron waves in a relativistic plasma immersed in a magnetic field, and in the presence of a nonrelativistic plasma. Unstable waves are found to exist in the following cases: when the momentum distribution is Maxwellian but anisotropic; when the momentum distribution is of the cosmic ray type and is anisotropic with a lower momentum cutoff; and when the momentum distribution is of the second type but isotropic and also possesses a loss cone. Maximum amplification rates are found for these three cases and are illustrated numerically by assuming physical values appropriate to the Crab Nebula and Cassiopeia A. (auth)

19313 TECHNIQUES FOR STUDYING ELECTRONS DURING IONIZATION AFTERGLOWS. V. A. J. van Lint, J. Parez, D. Trueblood, and M. E. Wyatt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Rev. Sci. Instr., 36: 521-8(Apr. 1965).

The ionization afterglow techniques involve the production of electron-ion pairs in a glass by a short pulse of high energy nuclear radiation, 20 to 30 Mev electrons in this case. The electron density and electron-atom collision frequency are measured by passing through the dilute plasma formed a microwave signal, whose amplitude and phase shift are measured with a microwave detector in a bridge configuration. An X-band microwave cavity and a 300 Mc cavity were also utilized to perform measurements with higher sensitivity at lower pressures. The results from these experiments include determinations of electron attachments and electron-ion recombination coefficients as well as momentum and energy transfer cross sections. In common with other afterglow techniques, the measurements usually refer to a thermally averaged electron energy spectrum. Some specific examples from studies of momentum and energy transfer, as well as electron-ion recombination in nitrogen, are presented. (auth)

19314 NUCLEAR FUSION AND ITS ROLE AS AN ENERGY SOURCE. J. G. Linhart (CNEN, Frascati, Italy). Scientia (Milan), 99: 37-41(Feb.-Mar. 1964).

The development of controlled nuclear fusion processes is outlined, as well as its extension to plasma confinement problems. Economic aspects of fusion power generators are emphasized. The possibility of adapting fusion reactions to a continuous plasma fusion process was suggested in 1951 when it was realized that this might be achieved by confining deuterium or deuterium-tritium plasma by a strong magnetic field. The minimum D–T plasma temperature (at which fusion power outweighs losses) was estimated to be about 50 million degrees. Plasma at this temperature is a better conductor than copper and magnetic fields should be able to exercise control over it. The possible number of different magnetic field configurations capable of confining the hot plasma in a stable manner has dwindled considerably during the past ten years. Many other difficulties have arisen, blocking progress towards a fusion reactor, and today it is still not clear whether such a reactor is possible. Apart from doubts about ability to develop a fusion reactor, doubts whether such a reactor will be economic or even necessary have arisen. Economic considerations are discussed in terms of possible future fusion reactors of four general categories: (1) reactors relying on long confinement, in which the reactor components are not suddenly destroyed; (2) reactors with short confinement, the reactor being destroyed after each energy burst; (3) ordinary H bombs relying on practically no confinement; and (4) reactors with no confinement, in which only the discharge chamber is partially damaged. The criterion of nondestruction limits magnetic fields to lower than ½ Mgauss (plasma pressures below 10,000 atm) and consequently to low plasma densities and long confinement times. Apart from the fact that these long times have not been yet achieved, it has been already demonstrated that the class (1) reactors could run only on a mixture of D and T (pure D plasma requires much higher temperatures than D–T; at such temperatures the cyclotron radiation loss outweighs the fusion power) and therefore, T will have to be bred in the reactor, probably utilizing ^{6}Li blankets. The coils producing the confining magnetic field will have to be made superconducting to reduce the magnet dissipation, and these coils will not be simple structures, as the magnetic field required by the criteria of plasma stability is geometrically complicated. All these complications preclude a simple reactor at the power level of 100 Mw or more and, therefore, it appears that this class of reactors will not be economically competitive with fission reactors. Only a radically new discovery in the field of plasma confinement could alter this outlook. Reactors of the second class rely on confinement times that have been already achieved in lab; however, in order that within these short times the fusion energy produced outweighs the input energy very high plasma densities are required, which, in turn, require confining magnetic fields higher than 10 Mgauss. To produce such high magnetic fields, high explosives must be used, and thus, reactors of this type will be destroyed after each shot. Since the fusion energy generated per shot must be worth at least the cost of the destroyed components, the economic fusion energy burst per shot must be equivalent to a fraction of one kiloton of TNT. It is concluded that fusion energy generation should be based on relatively simple devices, capable of generating power of at least 100 Mw/reactor at a running cost comparable to fission reactors. At the present state of knowledge this does not seem impossible. (BBB)

19315 SPECTROSCOPIC INVESTIGATIONS ON ARGON HIGH CURRENT ARCS. Wilhelm Boegershausen and Hans Krempl (Technische Hochschule, Munich). Z. Angew. Phys., 18: 290-5(1965). (In German)

A variant of the argon safety gas welding arc was investigated. Temperatures over 10,000°K with low power output could be produced. For plasma-chemical studies, an arc burner free of cathode and anode vapor was developed. The plasma composition of the argon was calculated for the spectroscopic study of this arc, and the term diagram of the Ar I, Ar II, and Ar III was established in the spectral range from 4800 to 2900 A. With the help of these terms or their normal temperature, the radial temperature distribution of the arc was measured and the arc mechanism was discussed. (tr-auth)

19316 SPECTROSCOPIC INVESTIGATIONS OF THE THERMODYNAMIC EQUILIBRIUM OF EXCITATION IN THE PLASMA SHORT-TIME PULSE DISCHARGES. Jan van Calker and Johannes Lensing (Universitat, Munster, Ger.). Z. Physik, 184: 130-42(1965). (In German)

The light emission of gases conducting electric discharges is of considerable complexity. The observed phenomena are controlled to a great part by the electric parameters of the circuit, as well as by the time constants of the specific plasma properties as the relation times for reaching Maxwellian distribution and thermal equilibrium of electrons, ions, and atoms. The influence of the nonequilibrium between the excitation and the electron temperature on the population of states was studied in short time discharges by means of singulet and triplet lines of elements of the second group of the periodic system. In these discharges a nonequilibrium was found between the excitation and the electron temperature. While the time constant measured for the cooling of the electron gas was found to 7×10^{-7} sec in a discharge switched off 9×10^{-7} sec past the ignition the minimal time constant of relaxation of excitation is equal to the life time of the $2p_2$ state, this value of cadmium being 2.4×10^{-8} sec. The use of Boltzmann and Saha equation must be considered very carefully in this type of short time discharges. (auth)

19317 PLAZMENNYE ISTOCHNIKI IONOV. (Plasma Ion Sources). M. D. Gabovich. Kiev, Naukova Dumka, 1964. 224p.

A review is made of published literature on gas-discharge ion sources. Atomic and molecular hydrogen ions, multicharged ions, electrons and other plasma ion sources are discussed. Ion extraction and primary formation of ion beams, yield into the quasi-neutral ion flux vacuum, and plasma oscillation properties are also discussed. 416 references. (R.V.J.)

19318 FIZICHESKAYA GAZODINAMIKA SVOISTVA GAZOV PRI VYSOKIKH TEMPERATURAKH. (Physical Gas-Dynamics. Gases at High Temperatures). A. S. Predvoditelev, ed. Moscow, Izdatel'stvo "Nauka," 1964. 223p.

Properties of plasma at high temperatures are reviewed. Studies were made of thermodynamic properties of gases, thermal ionization of air, radiowave diagnostics of gases heated by shock waves, diagnostics of plasma in a magnetohydrodynamic shock tube, and plasma propagation in a discharge tube with coaxial electrodes. Physical properties of argon plasma, losses in the shock wave reflection from the shock tube end window, shock wave velocity in rarefied gases, corona discharge effects on convective heat exchange and electric and thermal properties of solid electrolyte thermistors are also discussed. (R.V.J.)

19319 NON-LINEAR WAVE PROPAGATION. With Applications to Physics and Magnetohydrodynamics. A. Jeffrey and T. Taniuti. Mathematics in Science and Engineering. A Series of Monographs and Textbooks. New York, Academic Press, 1964. 377p.

Mathematics of nonlinear wave propagation are discussed, including quasilinear hyperbolic systems, the theory of characteristics, conservation laws, and weak solutions. Applications of the theory to MHD are considered, with discussions of fundamental equations, simple waves, MHD shocks, hydromagnetic-wave interactions, spatial discontinuities, and the Riemann problem. 94 references. (M.J.T.)

19320 CONTROLLED THERMONUCLEAR REACTIONS. L. A. Artsimovich. Edited by A. C. Kolb and R. S. Pease. Translated by P. Kelly and A. Peiperl from "Upravlyaemye Termoyadernye Readtsii." New York, Gordon and Breach Science Publishers, 1964. 418p. $19.50.

The original Russian book was previously abstracted for NSA; see abstract 19: 5386. (M.J.T.)

19321 INSTABILITIES IN SOLID-STATE PLASMAS. Setsuo Ichimaru. p.103-37 of "Fluctuation Phenomena in Solids." New York, Academic Press, 1965.

The dielectric response function of plasmas is defined, and its calculation in the random phase approximation and analytic properties are described; the dielectric description of plasma properties is discussed. Plasma wave instabilities and the approach to equilibrium of electrons and plasma waves are considered. Fluctuations in plasmas are described, with consideration of critical fluctuations, the fluctuation-spectrum sum rule, and impurity-scattering effects. 53 references. (M.J.T.)

19322 PLASMA DIAGNOSTIC WITH MICROWAVES. M. A. Heald and C. B. Wharton. Wiley Series in Plasma Physics. New York, John Wiley and Sons Inc., 1965. 469p. $13.50.

Basic theory of the interaction of electromagnetic waves with plasmas is summarized, and practical experimental techniques using this interaction are described. The propagation of externally generated waves in a plasma is treated, including the Appleton-Hartree theory of wave propagation, an examination of the role of collision processes, consideration of the boundaries and spatial nonuniformity of real plasmas for propagation of free-space beams and for plasma confined in a resonant cavity or waveguide; an extensive discussion of the practical applications of these active microwave probing techniques is given. The theory of microwave radiation generated by a plasma, by thermal and nonthermal processes, and the practical application of passive radiometric techniques are presented. Descriptions and photographs of hardware and special circuits for microwave diagnostics, not available commercially, are given. Plasma diagnostic techniques besides microwaves are surveyed briefly. 600 references. (M.J.T.)

19323 THE TEMPERATURE-INTENSITY-PRESSURE SURFACE AND ITS APPLICATION TO PLASMA SPECTROSCOPY. Ronald Lee Fox (McDonnell Aircraft Corp., St. Louis). 5p. (CONF-812-3)

From Society for Applied Spectroscopy 3rd National Meeting, Cleveland, Sept.-Oct. 1964.

The equation for temperature, spectral intensity, and stagnation pressure is developed for a monatomic partly ionized plasma. The temperature-intensity-pressure (TIP) equations shown to be represented by a four dimensional surface, every point of which is an allowed value for the plasma parameters. The plasma parameters can thus be obtained by the simultaneous solution of n TIP equations, where n is an integer given by the thermodynamic state of the plasma (n = 3 for a real plasma in equilibrium). Methods for solving the TIP equations are discussed. (auth)

19324 EXPANSION SOLUTIONS AND WAVE PROPAGATION IN PARTLY IONIZED GASES. David Kahn (Raytheon Research Div., Waltham, Mass.). 61p. (CONF-543-21)

From American Physical Society 1964 March Meeting, Philadelphia, Mar. 1964.

Kinetic theory solutions of the Boltzmann equations for a partly ionized gas are obtained for the study of wave propagation in a three fluid plasma. The following simplifying assumptions are made: the interactions between charged particles are divided into long range coulomb forces which effectively act as an external electric field, and a short range coulomb force which is cut off at the Debye length; the interactions between other pairs of particles are assumed to obey an inverse fifth power law. Further, the gas is assumed to be sufficiently close to equilibrium for the usual expansions of the velocity distribution functions around the equilibrium distribution functions to be used. Under these assumptions, the general sets of coefficient equations are obtained, and a 13-and 20-coefficient approximation (which include the effects of self-collisions or viscosity and thermal conductivity) are given explicitly. For a five-coefficient approximation, corresponding to employment of the conservation equations, a dispersion relation is obtained and solved for the phase velocities and attenuation of longitudinal waves as functions of wave and collision frequencies. It is found that the solutions which correspond to waves of high phase velocity are exactly those obtained when the adiabatic law is assumed to hold. Solutions corresponding to low phase velocity waves, however, are found to be more highly attenuated than their counterparts in the adiabatic theory. (auth)

19325 FUNDAMENTAL TOPICS IN RELATIVISTIC FLUID MECHANICS AND MAGNETOHYDRODYNAMICS. Robert Wasserman and Charles P. Wells, eds. Proceedings of a Symposium held at Michigan State University, October, 1962. New York, Academic Press, 1963. 248p. (CONF-621001)

Thirteen papers on the mathematical aspects of relativistic fluid mechanics and MHD are included. Subjects treated are the absence of a gravitational analog to electrical charge, hydrodynamics and general relativity, invariance groups, the cauchy problem and entropy in plasma, flow patterns at small R_m, stability of magnetofluid free boundaries, topological aspects in existence proofs in MHD, MHD wave propagation in a dipole field, Dorodnicyn's method of integral relations, hydrodynamic- and electrodynamic-field structure, momentum-transfer distribution functions in plasma, the flow of a low-viscosity conducting fluid, and the analogy of MHD and plastic flows. (M.J.T.)

19326 THERMOELECTRICAL CONTROL OF PLASMA. Wladimir von Maydell (to Bolkow-Entwicklungen Kommanditgelsellschaft). Canadian Patent 698,017. Nov. 17, 1964. Priority date Feb. 19, 1960, Germany.

A method of influencing a flowing plasma so as to focus

the plasma ray by generated thermocurrents is described. Means are provided to utilize the available energy of the plasma for heating and accelerating the ray and to utilize the radiated heat to build up a magnetic field for guiding, concentrating, and focusing. An arrangement of thermocouples defines a path for the flow of a plasma ray wherein the heat energy generates a magnetic field for controlling the ray. The device is made up of upper and lower spiral metallic conductors to define a flow path. (F.S.A.)

19327 PYROTRON THERMONUCLEAR REACTOR AND PROCESS. Richard F. Post (to U. S. Atomic Energy Commission). U. S. Patent 3,170,841. Feb. 23, 1965.

Methods and apparatus useful for the production and confinement of high-temperature plasmas including those of interest in the controlled fusion fields are discussed. Axially symmetric magnetic fields were provided with regions of gradientially intensified magnetic field strength serving as closures to effect containment. Operations including manipulation of the intensity and positioning of magnetic field regions are used to trap space-charge-neutralized beams of fuel ions as well as to provide heating, densification, and other desired conditions for high-temperature plasmas. Supplementary injection techniques together with other operations are also disclosed. (AEC)

Shielding

Refer also to abstract 18507.

19328 (EUR-2204.i) GAMMONE — PROGRAMMA MONTECARLO PER IL CALCOLO DELL'ATTENUAZIONE DEI RAGGI GAMMA ATTRAVERSO SCHERMI LAMINARI COMPOSITI. PARTE 1A. FONDAMENTI MATEMATICI DEL PROGRAMMA. PARTE 2A. CODIFICAZIONE DEL PROGRAMMA. (GAMMONE — Program for Gamma-Ray Attenuation Through Multilayer Composite Shields. Part 1. Mathematical Bases of the Program. L. Criscuolo. Part 2. Coding of the Program). L. Criscuolo and M. G. Cerisola (FIAT, Turin (Italy). Sezione Energia Nucleare). Jan. 1965. 120p. Dep.(mn).

The GAMMONE program is an IBM-704 code that applies Monte Carlo methods to simulate gamma ray life histories in a source–shield configuration. The physical and mathematical bases of such a program are described. The shield studied is a multilayer composite rectangular parallelepiped. The gamma source has different shapes, viz. point, line, infinite plane, and disc. Several techniques, such as importance sampling, are used for increasing the efficiency of a Monte Carlo calculation. The outputs of the code are energy and dose attenuation and build-up through the shield, as well as energy and dose reflection probability at the source-shield interface. The report presents the FORTRAN listing of the main program and of the seven subroutines, a short explanation of the use of such subroutines, some typical outputs, and detailed description of the input formats. (auth)

19329 (ORNL-3704) HIGH-DENSITY CONCRETE FOR GAMMA AND NEUTRON ATTENUATION. T. E. Northup (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 72p. Dep.; $3.00(cy), 2(mn) CFSTI.

The special aggregates needed to produce concrete shields capable of attenuating high and almost equal intensities of gamma and neutron radiation at a temperature of 100°C are described. Material acquisition and concrete test information on ferrophosphorus-limonite concrete and hydrous-iron-ore-limonite concrete is presented. Attention is given to high-density aggregate mining, iron-pyrite impurities in hydrous iron ore, and shielding aggregate data tables. The basic approach to high-density concrete mix design is reviewed to show that theoretical calculations for concrete mixes give results that are reliable. However, laboratory tests with the produced shielding aggregates are still required to confirm mix quantities, adjust workability, establish the need for additives, etc. before any concrete is actually placed. (auth)

19330 (ORNL-RSIC-5) BIBLIOGRAPHY, SUBJECT INDEX, AND AUTHOR INDEX OF THE LITERATURE EXAMINED BY THE RADIATION SHIELDING INFORMATION CENTER (DECEMBER 1964). S. K. Penny, D. K. Trubey, and M. B. Emmett (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 558p. Dep.; FREE(ORNL).

The bibliography is arranged under the following subject categories: general, nuclear and atomic information, radiation effects, transport theory, experimental techniques, results for simple geometries, shield design techniques, complex systems, and shielding materials. Nuclear weapons shielding is included. A keyword index is included along with the author and subject category indexes. (D.L.C.)

19331 (RRA-T44) UTILIZATION INSTRUCTIONS FOR GENERAL APPLICATION OF THE L05 MONTE CARLO PROCEDURE. D. G. Collins (Radiation Research Associates, Inc., Fort Worth, Tex.). May 29, 1964. Contract DA-49-146-XZ-254. 135p.

Instructions for the utilization of L05, a Monte Carlo procedure for performing neutron and gamma ray penetration and scattering calculations on the IBM-7090, have been rewritten to clarify and add detail to the previous instructions. The revised utilization instructions apply to the original L05 Code as well as to the RRA version of L05, which has been modified to enhance its applicability to general shielding calculations. A description of the principal mathematical relations used by the code in the solution of neutron and gamma ray transport problems is included. Detailed definitions and formats for the input data which comprise problem deck and the energy and element library decks are given. In addition, peculiarities in the input data requirements discovered in extensive use of the code are discussed. General operational information for running the code on the IBM-7090 are also given. (auth)

19332 ATTENUATION OF REACTOR RADIATION BY SERPENTINE CONCRETE. G. A. Vasilev, A. P. Veselkin, Yu. A. Egorov, V. A. Kucheryaev, and Yu. V. Pankrat'ev. At. Energ. (USSR), 18: 121-7(Feb. 1965). (In Russian)

Studies of shielding concretes with serpentine and limonite filler showed that the serpentine concrete has somewhat higher attenuation properties for neutron while for γ attenuation the properties of the examined concretes are similar. The serpentine concrete exhibited a higher thermal resistance and can be used as a reactor shielding up to 450°C. (tr-auth)

19333 EXPERIMENTAL INVESTIGATIONS OF RIZ REACTOR SHIELDING. S. P. Belov, V. A. Dulin, Yu. A. Kazanskii, V. I. Popov, and S. G. Tsypin. At. Energ. (USSR), 18: 136-40(Feb. 1965). (In Russian)

Descriptions are given of a test facility for a zero power uranium-water reactor designed for investigations of processes taking place in the active zone shielding. The data on the neutron formation spectra and strong γ radiation enable accurate estimates of the dimensions and weight for all reactor shielding to be made. The results of neutron spectrum measurements at the test facility and properties of shielding materials (iron, nickel, and boron nickel) are analyzed. (tr-auth)

19334 SHIELDING MEASUREMENTS ON 4.8-Gev BREMSSTRAHLUNG. G. Bathow, E. Freytag, and K. Tesch (Deutsches Elektronen-Synchrotron DESY, Hamburg). Nucl. Instr. Methods, 33: 261-7(Mar. 1965).

Bremsstrahlung produced by 4.8-Bev electrons impinges upon a quantometer; the emerging radiations and their attenuation in heavy concrete are measured. The following instruments are used: tissue-equivalent ionization chamber, argon-filled ionization chamber (Jordan chamber), neutron dosimeter, and several activation foils for measuring the neutron flux. Results are given for the neutron flux and dose rates of some radiation components behind concrete shielding up to 160 cm and at angles from 0 to 125°, for the attenuation coefficients of the radiation components, and for the number of giant-resonance neutrons produced per eq. γ quantum. (auth)

19335 ENERGY LOSS MEASUREMENTS WITH THE FONTANE SPECTROMETER. Franz Edelmann and Kurt Ulmer (Technische Hochschule, Karlsruhe, Ger.). Z. Angew. Phys., 18: 308-15(1965). (In German)

The characteristic energy loss of electrons in the primary energy range from 150 to 250 ev was measured by reflection for the transition metals Ta, Nb, W, and Mo. The energy analysis was made with a Fontane spectrometer that operates with a homogeneous electric deflecting field. It is described in detail, and its properties are compared with those of other spectrometers of similar construction. The Fontane spectrometer showed the highest efficiency (transmission × resolution). The characteristic energy loss measured was 13.5 ev for Ta, 12.6 ev for Nb, 12.5 ev for W, and 10.9 ev for Mo. A critical comparison is made with earlier measurements, and the necessity for atomically pure surfaces for these studies is established. This can be accomplished practically only through very high sample temperature during the measurement. It can be expected that the measurement of the characteristic energy loss can be one of the most sensitive methods for the testing of surface purity. (tr-auth)

19336 PROTON FLUX, DOSAGE AND DAMAGE ESTIMATES IN THE VAN ALLEN BELT. S. Russak and K. Richardson (Martin Co., Baltimore). 15p. (CONF-651-56)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Proton fluxes and spectra were obtained for a number of near earth circular and elliptical orbits. From these, radiation dose versus absorber thickness and solar cell damage estimates were made. The environmental model used to obtain flux uses McIlwain's empirical data from Explorer XV. The distribution of protons with energy as used in the calculation varies with position in the geomagnetic field in accordance with the relation derived by Imhof and Smith. These were combined into a single IBM 7094 program which determines the flux and composite incident spectrum at various points along the orbit and calculates emergent spectrum and dose within simple or complex configurations. The results obtained are compared with earlier dosage estimates based upon the Freden and White spectrum and a flux model derived from Explorer IV data. (auth)

19337 METHOD OF PRODUCING CONSTRUCTION ELEMENTS OF CONCRETE, ARTIFICIAL STONE, STONE WOOD OR SIMILAR CONSTRUCTION MATERIALS CONTAINING LEAD. Heinrich Drath. German Patent 1,183,419. Dec. 10, 1964. Filed Sept. 15, 1953.

Natural minerals containing metallic lead were the basic material for a binding with cement or any other binding agent, e.g., artificial resin. In order to obtain a material with neutron absorbing properties neutron absorbing substances were added to the cut-up or ground minerals. The construction elements is composed of two layers, the layer facing the radiation preferably containing neutron absorbing substances, and the layer facing the shielded room preferably containing gamma absorbing materials. (Gmelin Inst.)

REACTOR TECHNOLOGY

General

Refer also to abstracts 18112 and 18582.

19338 (BMI-X-10107) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report, October–December 1964. Duane N. Sunderman, David L. Morrison, James A. Gieseke, John C. Smith, and Craig T. Walters (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 45p. (EURAEC-1292). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Initial activities in a program to describe the consequences of accidents involving pressurized-water reactors and boiling reactors in which the maximum accident is considered to be loss of coolant are reported. Efforts during the period were devoted to assembling engineering design practices for these systems. Information concerning theories and experiments which may have application to the analytical description of loss-of-coolant accidents were located and documented. (J.R.D.)

19339 (CEA-Bib-17) LISTE DE CODES NUCLEAIRES UTILISES AVEC LES CALCULATEURS ARITHMETIQUES IBM-704, 709 ET 7090 (1er FASCICULE). (Bibliography of Nuclear Codes Utilized with IBM-704, 709 and 7090 Computers. Part I). Bernard Bornand (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Etudes Nucléaires). Nov. 1964. 72p. Dep.(mn).

The digital computer codes listed in this bibliography have been selected on the basis of the most useful codes for reactor computations. In the listing, the reactor codes are arranged chronologically in eight different categories: burnup, engineering, group diffusion, kinetics, transport, physics, Monte-Carlo, miscellaneous. Only burn-up, engineering, and group diffusion are issued in the first section. Machine, fast memory, and language are indicated. The number of the report that gives the details of the code is listed. Indexes of code names and authors are given. This bibliography has been reviewed from 1957 to March 1964. (auth)

19340 (ORNL-NSIC-4) BEHAVIOR OF IODINE IN REACTOR CONTAINMENT SYSTEM. G. W. Keilholtz and C. J. Barton (Oak Ridge National Lab., Tenn.). Feb. 1965. Contract W-7405-eng-26. 98p.

The properties of radioactive iodine are described through the stages of generation, release, transport, and deposition in a reactor containment system. Trapping systems for different forms of airborne iodine are discussed, and methods of evaluating their efficiency are described. The adsorption of iodine on particulate matter, the rate of deposition of iodine under various possible reactor accident conditions, and the formation of organic iodine compounds are aspects of iodine behavior now considered important in evaluating the hazards of nuclear reactor accidents and in establishing reactor site criteria. Methods of characterizing the forms of iodine and of inducing their removal from aerosols are compared and evaluated. Information is available on the behavior of iodine in a variety of environment, but few experiments have been performed that possessed all the elements of realism necessary for simulation of conditions likely to exist in loss-of-coolant accidents in water-cooled and/or -moderated reactors. Experiments to be performed in existing and projected facilities described should eventually meet the need for this type of data. The lack of certainty in regard to the chemical form in which iodine will exist in reactor accident environments makes it inadvisable at present to recommend a change in the factor-of-2 credit presently assumed for natural deposition phenomena. There is need for greater emphasis on large-scale testing of engineered safeguards under the most realistic accident conditions that can be devised in order to define their efficiency and to provide more confidence in their reliability. A broad program of laboratory investigations is also needed to aid in designing large-scale tests and in interpretations of the results. (auth)

19341 TWO-GROUP REACTOR THEORY. J. L. Meem. New York, Gordon and Breach Science Publishers, 1964. 427p.

The engineering analysis of reactors is emphasized rather than fundamental reactor physics. One group diffusion theory, Fermi age theory, and transport theory are introduced. The elementary kinetics of a bare reactor are considered, using Fermi theory. Control rod worth, heterogeneous reactors, and fast reactors are discussed using two group theory. Examples of reactor calculations are given for pool-type, heterogeneous, and fast reactors. (M.J.T.)

19342 SITING OF NUCLEAR POWER PLANTS. Camil Wlezek and Ana Florescu. Energetica (Bucharest), 12: 30-8(Jan. 1964). (In Rumanian)

Factors in the selection of reactor sites are reviewed, together with some solutions adopted and siting criteria developed. (D.C.W.)

Auxiliaries and Components

Refer also to abstract 18105.

19343 (CEA-R-2517) ENTRAINEMENT DES POMPES DU CIRCUIT DE REFRIGERATION D'UN REACTEUR PAR VOLANT A EMBRAYAGE SOUS COUPLE CONTROLE (THESE). (A Fly-Wheel Drive with Controlled-Torque Clutch for Reactor Cooling Circuit Pumps (thesis)). André Riettini (Commissariat à l'Énergie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Oct. 1964. 99p. Dep.(mn).

After a theoretical study on the slowing down of a centrifugal pump, the motion equations have been checked by means of experimental tests. In order to have long slowing down times (which is the case in the cooling pumps of a research reactor) it is necessary to add a fly wheel. To prevent troubles when starting, a block pump-flywheel with clutch under controlled torque was developed. It is thus possible to start the flywheel progressively without increasing too much power of the driving motor. (auth)

19344 (NAA-SR-9287) HIGH-TEMPERATURE EXPERIMENTS ON FISSION-PRODUCT RETENTION IN SODIUM. W. P. Kunkel, D. M. Elliott, and A. S. Gibson (Atomics International, Canoga Park, Calif.). Feb. 1, 1965. Contract AT-11-1-GEN-8. 61p. Dep.; $3.00(cy), 2(mn) CFSTI.

Experiments have been performed to evaluate the extent of retention for fission products released into high temperature sodium. Both in-pile and out-of-pile experiments were performed with sodium temperatures of 1000°F for in-pile studies and ranging from 900 to 1400°F for out-of-pile studies. In the in-pile studies, small discs of preirradiated uranium metal were melted and a portion of the fission product inventory was dispersed in molten sodium by a transient neutron burst. In the out-of-pile study, fission products were injected by recoil during the preirradiation and by diffusion during the heating. Data were obtained in both cases by sampling the helium cover gas space above the sodium interface and relating the fission product activity observed to that measured in the sodium and to the estimated inventory of the preirradiated fuel. Severe cases in which up to 70% of the iodine inventory is released to the sodium have been tabulated. This compilation suggests that under these temperature conditions approximately 2×10^{-4} of the iodine trapped in so-

dium may be available for further release to the environment. (auth)

19345 (NAA-SR-9967) FLUX CONTROL FOR IRRADIATION EXPERIMENTS. W. K. McCarty (Atomics International, Canoga Park, Calif.). Feb. 1, 1965. Contract AT(11-1)-Gen-8. 51p. Dep.; $3.00(cy), 1(mn) CFSTI.

This report reviews various means which have been used to control experimental conditions in irradiation experiments, and presents the concept of local flux control. The concept presented involves an irradiation facility, consisting of an annular can or circle of small tubes containing boron trifluoride, and a test element which is inserted within the facility. The density of the BF_3 may be varied, during operation, to control the flux at any single given point in the test element. The reactor coolant flows through the volume enclosed by the facility and around the outside of the facility, to cool it and the test element independently. The purpose of this concept is to permit irradiation at controlled flux, and hence at controlled burnup rate and temperature conditions. This system removes cycle-to-cycle flux variation. While the system cannot stop the axial movement of the peak flux in the irradiation position, it can maintain a constant flux at one point or a constant average flux, based upon the average output of a finite number of thermocouples. Based upon experimental data obtained from two experiments in the Engineering Test Reactor, advanced concepts are proposed that would permit local flux flattening or shaping, in addition to control of peak flux, to provide desired experimental conditions. (auth)

19346 (WCAP-3269-32) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. DEVELOPMENT OF REACTOR COOLANT SYSTEM. H. J. Cordle (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Sept. 1964. Contract AT(30-1)-3269. 61p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The conceptual design of the reactor coolant system for large closed-cycle water reactors with chemical shim control is described. Significant areas of development are discussed and descriptions of the system conceptual design are included for a plant rated at 1176 Mwt. (auth)

19347 AN INSTALLATION FOR MEASURING REACTOR PERIOD AND LEVEL. Ferenc Vajda and Endre Vegh. Meres Automat., 12: 334-8(Nov. 1964).

An installation designed for measurements at low flux level is described. The detectors supply the information, which is in relation to the neutron flux, in the form of an average impulse frequency; this information is further processed by a unit constructed on the basis of subracks. The impulses are amplified, discriminated, and counted on an incidence counter operating logarithmically. Two outputs are provided; one for the logarithmic rate meter and the other for the period meter. The technical specifications of the unit were presented and performance experiences were briefly discussed. (OTS)

19348 POOL-TYPE NUCLEAR REACTOR THERMAL COLUMN. Wm. A. Pitt (to General Electric Co.). Canadian Patent 702,202. Jan. 19, 1965. Filed Nov. 10, 1961.

Instead of a boral covering, the thermal column described is encased in aluminum and then surrounded by a layer of circulating neutron moderating and reflecting liquid at least 2 inches thick. Such a structure is claimed to provide higher thermal neutron flux at its output for a reduced cost. (F.S.A.)

19349 CONTROL ROD DRIVE MECHANISM. David Nicoll (to U. S. Atomic Energy Commission). U. S. Patent 3,170,844. Feb. 23, 1965.

A reactor control rod drive was designed to afford hermetic sealing of a pressurized, fluid-containing reactor system by avoiding need for passing drive members through sliding seals to the outside. Integral with the reactor pressure vessel, a tabular thimble contains a reciprocal piston connected by a push-rod to the control rod. An electric-motor-driven lead screw drive, also entirely within the thimble, serves to move the control rod slowly during normal operations. Admission of reactor system fluid after further pressurization to the face of the piston, assisted by automatic declutching of the lead screw drive, affords high-speed rod insertion during a "scram," while avoiding hazard of inleakage of fluid contaminants. (AEC)

Criticality Studies

See also PHYSICS — Criticality Studies.

Refer also to abstract 19073.

19350 (AD-605022) THE EFFECTS OF NEUTRON IRRADIATION ON REACTOR FUEL COMPOSITION AND REACTIVITY. Lecture Notes. G. Safonov (RAND Corp., Santa Monica, Calif.). Feb. 22, 1956. 28p. $2.00(CFSTI)

Topics include: the transmutation chains of nuclear fuel (approximate chains for reactor work, and concentrations of chain nuclei as a function of irradiation); effects of irradiation on reactor reactivity (the concept of a "design" reactor and "design" operating conditions, the "reactiveness" of fuel, and examples of "off-design" reactor operation); and remarks on feed costs for U-235 and U-238 burners. (auth)

19351 (AEEW-M-477) EXTENSIONS TO THE COMPUTER CODE FLIRT. M. E. R. Veale and H. E. Wrigley Atomic Energy Establishment, Winfrith (England)). Nov. 1964. 9p. Dep.; $0.30(BIS); 1s. 9d. (HMSO).

Three additional facilities incorporated in the latest version of the reactor transient program FLIRT (version III) are described. These are fission product heating, Wigner energy release, and the option of straight through, or re-entrant coolant flow. The additional data required and its presentation are also described. (auth)

19352 (AEEW-R-393) ON THE RELATIONSHIP BETWEEN THE TRANSFER FUNCTIONS AND THE CHARACTERISTIC MODES OF A SET OF ORDINARY FIRST ORDER DIFFERENTIAL EQUATIONS. C. B. Guppy (Atomic Energy Establishment, Winfrith (England)). Aug. 1964. 26p. Dep.; $0.70(BIS); 3s. 6d. (HMSO).

An attempt is made to describe how the Transfer Functions of a system of ordinary differential equations can be derived in terms of the latent roots and vectors of the matrix of coefficient for the dependent variables of the system. It is shown that when the latent roots and vectors are known the formulation of the modes of the system and of its transfer functions is straight forward. The treatment itself is simple and starts almost from first principles. A description of how to get a general set of differential equations into the correct form, the meaning of latent roots and vectors, how the transfer functions arise, the significance of complex latent roots and vectors and, finally, the modal significance of a system at its stability limit is included. Two simple fully worked samples are included. (auth)

19353 (AEEW-R-400) A BINARY CROSS-CORRELATION ANALYSER. J. F. Hogg (Atomic Energy Establishment, Winfrith (England)). Nov. 1964. 27p. Dep.; $0.80 (BIS); 4s. (HMSO)

The basic design principles and features of a versatile analyzer for investigating the characteristic of dynamic systems such as nuclear power plants are outlined. (auth)

19354 (ANL-6866) EXPERIMENTAL INVESTIGATIONS OF SECONDARY CRITICAL CONFIGURATIONS (ZPR-III ASSEMBLIES 27 AND 28). W. Gemmell, J. K. Long, and W. P. Keeney (Argonne National Lab., Ill.). Nov. 1964. Contract W-31-109-eng-38. 36p. Dep.; $2.00(cy), 1(mn) CFSTI.

Two configurations of a fast reactor core following a postulated accidental meltdown were investigated. The configurations were chosen to represent nonuniform distributions of fuel in which calculations of flux and reactivity worth could be compared with experimental values. The first configuration represented a case in which the center of a core had melted, and the top and center portions had collapsed into a dense fuel mass in the bottom of

the reactor. The dense region is then surrounded by an annulus with the normal core composition, and this in turn is surrounded by the normal blanket. The second configuration represented a core in which vaporizing sodium caused the expulsion of all material from the axis of the core, and the annulus had melted and collapsed into a dense ring of fuel. If these situations were encountered in an actual meltdown, a secondary critical or supercritical configuration of fuel could occur. The history of this secondary configuration would be governed by the spatial relationships of the fuel worth, power distribution, and degree of criticality. The relationship of the power and fuel-worth distributions would determine if further motion of the fuel would result in an autocatalytic configuration. The experiments in the Zero Power Reactor III (ZPR-III) provided fission-rate and reactivity-worth distributions, which may be used to evaluate calculational methods designed to describe the history of possible accident configurations. (auth)

19355 (BNL-8950) ANISOTROPIC MIGRATION IN SLAB LATTICES. Henry C. Honeck and Bernard C. Quiquemelle (Brookhaven National Lab., Upton, N. Y.). Feb. 25, 1965. Contract AT-30-2-GEN-16. 21p. (CONF-650504-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Pulsed Neutron Methods, Karlsruhe, Ger.

A numerical method is developed for computing anisotropic diffusion lengths in a slab lattice. The method is applied to aluminum–water lattices and results are given for a wide range of slab thicknesses and volume ratios. (auth)

19356 (EURAEC-1290) THE STEADY STATE AND DYNAMIC BEHAVIOUR OF A BOILING WATER REACTOR. Quarterly Progress Report XV, July 1–October 1, 1964. (Technische Hogeschool, Eindhoven (Netherlands)). Work Performed under United States–Euratom Joint Research and Development Program. Contract P-313. 19p. (WWO16-R78). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Some changes in the set-up of the pressurized boiling water loop have been tried out, to avoid severe water level changes, using an annular test section with a 60 mm shroud. The removal of the perforated plate in the steamspace, used for detaining the water droplets present in the steam, gave the desired result. Experiments were started, using an annular test section with a 50 mm shroud. Measurements in steady states, on the onset and character of hydraulic oscillations at different temperatures have been carried out. The recording equipment was changed in order to accelerate the measurement. By using the transfer-function analyzer, the frequency response characteristics of all signal channels from gage to magnetic tape have been determined. The computer program of the theoretical description by Jahnberg has been adapted to the code suited for the TR-4 digital computer. A mathematical model based on first principles has been tested. Also, this program is being adapted to the code of the TR-4 During testing, mathematical instabilities occurred due to the assumed temperature distribution. These have been overcome. (auth)

19357 (EURAEC-1302) SWIRL FLOWS IN BOILING WATER. CORELO— A NEUTRONIC CONSTANTS CALCULATION PROGRAM FOR LIGHT WATER AND SLIGHTLY ENRICHED URANIUM OXIDE REACTORS. Special Report No. 18. G. du Boucheron and J. Martinaud (Société Nationale d'Études et de Construction de Moteurs d'Aviation, Suresnes (France). Division Atomique). [nd]. Work Performed Under United States–Euratom Joint Research and Development Program. Contract 058-61-7-RDF. 29p. (EURATOM-18) Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A description is given of the CORELO program for the IBM 7040 computer. This program enables either the k_∞ of a reactor to be calculated taking an average void fraction value, or the macroscopic constants of the medium to be calculated and to bring them out in the form of data cards for LOUISE I or WANDA programs. (C.E.S.)

19358 (EURAEC-1303) SWIRL FLOWS IN BOILING WATER. STUDY OF AXIAL FLUX DEFORMATION IN A BOILING WATER REACTOR WITHOUT CONTROL RODS. Special Report No. 19. J. Martinaud (Société Nationale d'Étude et de Construction de Moteurs d'Aviation, Suresnes (France). Division Atomique). [nd]. Work Performed Under United States–Euratom Joint Research and Development Program. Contract 058-61-7-RDF. 10p. (EURATOM-19) Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The neutron flux distribution in a boiling water reactor channel without control rod and for the rated conditions is calculated. Macroscopic neutron constants were calculated by the R. W. Deutsch method. Flux distribution was calculated by iteration between the results given by a diffusion code and the void fraction that results from this flux distribution. Two diffusion codes were compared: LOUISE I and WANDA. (auth)

19359 (RPI-328-19) MONOP3— A FORTRAN II PROGRAM FOR THE PHILCO-2000 COMPUTER TO SOLVE THE TWO-DIMENSIONAL EQUIVALENT CELL PROBLEM IN THE P_3 APPROXIMATION. Thomas E. Dudley (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science). [nd]. Contract AT(30-3)-328. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

MONOP3 is an analytical, two-dimensional, monoenergetic, P_3 spherical harmonics treatment of the equivalent-cell problem of infinite, cylindrical rods placed in a regular polygonal array. (T.F.H.)

19360 (UCRL-12200) STUDY OF SOLID-MODERATED ENRICHED URANIUM EPITHERMAL SYSTEMS BY USE OF THE PULSED NEUTRON TECHNIQUE. John R. Morton, III (Lawrence Radiation Lab., Univ. of California, Livermore). Nov. 18, 1964. Contract W-7405-eng-48. 38p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The pulsed-neutron technique has been applied to subcritical assemblies to accumulate data useful for the testing of multigroup calculational methods. The measurements were generally of two types: studies designed to examine the properties of fuel-moderator systems; and studies of the effects of various single perturbations upon the fuel-moderator system. The pulsed-neutron method is particularly suited to the latter application because the relative worth of such a perturbation can be measured quite directly with high precision. The subcritical assemblies used for this purpose were semihomogeneous systems composed of fully enriched uranium foils with moderators of thin blocks of either graphite or beryllium oxide. These systems emphasized simple idealized geometries rather than detailed mockups of specific configurations. The fuel densities of nearly all the systems were sufficiently high to produce epithermal neutron spectra. The assemblies can be characterized by their moderator-fuel ratios. The BeO-moderated systems (ρ_{BeO} = 2.86 g/cm^2) were BeO/^{235}U = 123, 247, 329, 493, and 3830; their prompt neutron decay constants at delayed critical, $\alpha_c (=\beta_{eff}/l^*)$, were 590, 270, 192, 123, and 21.5 sec^{-1}(±3%). The graphite-moderated systems (ρ_c = 1.64) were C/^{235}U = 598, 1200, 2280, and 9103 with corresponding α_c values of 150, 70, 38, and 9.5 sec^{-1}(±3%). A sensitive test of multigroup cross sections was performed using the measured values of α_c and $\Delta\alpha/\Delta B^2$ with calculated values of $\Delta k/\Delta B^2$ to deduce β_{eff}. Deviations from the expected β_{eff} may be attributed to deficiencies in cross sections. Perturbations studied yielded the worths of reflector materials in slab geometry adjacent to one face of a subcritical assembly and absorber samples in slab or bar geometries centrally located within an assembly. Such measurements permit direct deduction of reflector savings or poison costs to core reactivity; more refined analysis permitted evaluation of scattering and absorption cross sections and resonance integrals. Reflector studies were made with systems having BeO/^{235}U = 247; absorber studies were made with systems with BeO/^{235}U = 247 and 493, and C/^{235}U = 598. (auth)

19361 (UCRL-13138) INSTRUCTION MANUAL FOR PROMPT BURST CRITICAL ASS'Y MACHINE, "SUPER

KUKLA." (Baldwin-Lima-Hamilton Corp., Eddystone, Pa. Industrial Equipment Div.). [1964]. Contract [W-7405-eng-48]. 40p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A description of the prompt burst critical assembly Super Kukla is given, and the principle of operation, instrumentation, and maintenance is discussed. (C.E.S.)

19362 (WAPD-T-1721) THE REPRESENTATION OF THE FEW-GROUP CROSS SECTIONS IN MULTIREGION DIFFUSION-DEPLETION CALCULATIONS. R. J. Breen (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1965. Contract AT(11-1)-Gen-14. 15p. (CONF-654-52). Dep. (mn); $1.00(cy), 1(mn) CFSTI.

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The problem of representing few-group cross sections in diffusion-depletion programs is discussed. A solution to the problem was developed using n-dimensional tables, where each independent variable defines a table dimension. The interpolation procedure is illustrated by examples. The application to temperature feedback effects in water-moderated reactors is given. Finally, the one-group representation of thermal neutrons is considered. (D.L.C.)

19363 HOMOGENEOUS CRITICAL ASSEMBLY WITH PROFILED (SHAPED) FUEL LOADING. A. K. Krasin and E. I. Inyutin. At. Energ. (USSR), 18: 175-7(Feb. 1965). (In Russian)

A critical assembly scheme for a six-zone zero-power cylindrical reactor fueled with $UO_2(NO_3)_2$ acidified with nitric acid is described. Various concentration fuel delivered through polyethylene tubes maintained the same solution level in each zone. The radial neutron flux distribution in the active zone center was measured using indium tracers. The reactor reached criticality at the active zone level 39.6 ± 0.1 cm which corresponds to the critical load of 3250 ± 30 g ^{235}U. The diagram of radial neutron flux measurements shows the presence of bursts in the thermal neutron distributions which is characteristic of the multizone systems. The coefficient of non-uniform fission distribution along the radius is equal to 1.19. The profiled fuel loading law leading to a constant mean energy release along the reactor radius was estimated on the basis of the obtained data and on the assumption of weak thermal neutron field variations. The diagram of thermal neutron flux distribution and energy release for the given conditions is included. (R.V.J.)

19364 A STUDY OF PLUTONIUM RECYCLE IN A GAS-COOLED, GRAPHITE-MODERATED REACTOR. [PART] III. Kunihiko Uematsu (Atomic Fuel Corp., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 57-61(Feb. 1965).

Reactor physics characteristics related to plutonium recycling in a gas-cooled, graphite-moderated reactor were investigated and correlated to those for the case without plutonium recycling, using the fuel cycle analysis code FUELMOVE. It was found that, in the initial stages of irradiation, plutonium recycled fuel shows a thermal spectrum harder with respect to neutron temperature and a higher slowing-down density, but that differences become smaller as the burnup progresses. A notable difference between the cases with and without recycling was found in the resonance fission rate, which proved to be roughly 20 to 35% higher in the former case. (auth)

19365 IMPROVEMENT IN S/N RATIO OF REACTOR NOISE SPECTRAL DENSITY. Tsutomu Nomura (Nippon Atomic Industry Group Co., Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 2: 76-7(Feb. 1965).

A technique for reducing spurious noises in a reactor was studied. The use of two detectors with independent electronic circuits, and direct analysis of the correlation power spectral density, brought about mutual culmination of the uncorrelated noises (chamber noise and instrumentation noise), and the reactor noise from the two detectors reinforced each other. It was observed that the reactor noise spectral density hidden in each spectral density is obtained in the high-frequency region, and the S/N ratio of the reactor spectral density is improved. (M.C.G.)

19366 A TRANSPORT THEORETIC CALCULATION OF THE DISADVANTAGE FACTOR. Joel H. Ferziger and Alan H. Robinson (Stanford Univ., Calif.). Nucl. Sci. Eng., 21: 382-9(Mar. 1965).

The disadvantage factor of a two-region slab lattice was calculated using Case's formalism in one-velocity transport theory. Although the problem was not solved exactly, the Fredholm equations for the expansion coefficients which are derived converge extremely rapidly under iteration. For the numerical calculations, an IBM-7090 code based on the results was written; the disadvantage factor can be calculated with this code in two seconds. The problem treated is highly idealized, but Case's formalism admits extensions and may lead to efficient means of calculating disadvantage factors for more realistic models. (auth)

19367 STATISTICAL-ERROR ESTIMATION FOR THE TRANSFER-FUNCTION MEASUREMENTS OF A NOISY REACTOR SYSTEM. C. Hsu and W. C. Lipinski (Argonne National Lab., Ill.). Nucl. Sci. Eng., 21: 407-8(Mar. 1965).

The statistical errors in transfer function measurements are investigated. (D.C.W.)

Design and Feasibility

19368 MODERN TECHNIQUES USED IN NUCLEAR DESIGN OF REACTORS. G. D. Joanou and H. B. Stewart (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Ann. Rev. Nucl. Sci., 14: 259-86(1964).

The progress of reactor physics methods development is described. The current status of cross-section data for some critical nuclides is reviewed briefly. Progress in neutron-thermalization and resonance-absorption calculational methods is examined. Newly developed calculational procedures used in reactor design are mentioned. Examples of computer programs developed for reactor design calculations are presented. 55 references. (M.J.T.)

19369 BOILING WATER NUCLEAR REACTORS. Stanley Hackney (to United Kingdom Atomic Energy Authority). Canadian Patent 700,393. Dec. 22, 1964. Filed Dec. 11, 1961.

Pressurized heavy water serves as moderator and heat transfer medium moving in closed circuit over the fuel rods. Light water coolant surrounds the pressure tubes, which are joined at the top in such a way as to establish radial flow paths thus facilitating boiling. The steam chamber at the top connects with the turbine and condensate is returned to the bottom. Since steam cannot touch defective fuel elements expensive containment is avoided. (F.S.A.)

19370 PASTE REACTOR. Roland Philip Hammond (to U. S. Atomic Energy Commission). U. S. Patent 3,170,843. Feb. 23, 1965.

A fast neutron breeder reactor utilizing a paste fuel of uranium or a uranium compound, a coolant enclosure tank, an alkali metal coolant, and coolant inlet and outlet means connected in fluid communication to the tank is described. It has a plurality of core and blanket tubes, which are closed at the bottom and positioned vertically within the tank. The core and blanket tubes are connected in fluid communication to a first header, and the header is connected to an external processing means whereby the fission products are separated from the fuel. A plurality of purge tubes are positioned inside each of the core and blanket tubes. The purge tubes are closed at the bottom by a filter and spaced from the wall of the core and blanket tubes. They are also connected in fluid communication to a second header positioned above the first header. (AEC)

Fuels

Refer also to abstracts 18124 and 18391.

19371 (EUR-2208.f) ETUDE PHYSIQUE DES CYCLES DE COMBUSTIBLES CENTRALE A GRAPHITE URANIUM

NATUREL. (Fuel Cycles Physical Study for Natural-Uranium Graphite Gas-Cooled Reactors). A. Meyer-Heine (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Dec. 1964. 180p. (CEA-762). Dep.(mn).

Fuel burn-up of graphite gas-cooled reactors is usually set at 3500 Mwd/t. The influence of higher burnup on reactivity balance and economy is studied. A refueling scheme is defined first in order to obtain the longest in-pile life of the fuel element. To avoid the use of complex computer programs, lattice constants have been turned into simple formulas, which are valid in the usual range of French reactors. The influence of burnup on the definition and economics of a power-plant is then studied. The possibility of obtaining burn-up as high as 5500 Mwd/t is shown. Particular problems, such as isotopic composition, moderator temperature coefficient, and transitory cycles are considered. The use of ^{235}U low enriched fuel turns out to be of a doubtful interest. The influence of uncertainties on the basic assumptions, and in particular on effective cross sections and the importance of a program of chemical and isotopic analysis of irradiated fuels, even with low burnups, is shown. (auth)

19372 (LA-3168) MULTIREGION THERMAL ANALYSIS OF TUBE BUNDLES WITH MOLTEN REACTOR FUEL IN FREE CONVECTION. Roy A. Axford (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Sept. 15, 1964. Contract W-7405-eng-36. 78p. Dep.; $3.00(cy), 2(mn) CFSTI.

The two-dimensional, fully developed temperature and velocity fields occurring in molten reactor fuel tubes in triangular tube bundles are analyzed on a coupled, multi-region basis. The three regions are the molten reactor fuel region, the tube wall region, and the coolant region. The molten reactor fuel is assumed to be in laminar flow, while the coolant is either slug flow or laminar flow. Analytical and numerical results for the temperature and velocity fields of the three regions and the circumferential variations in the inside and outside tube wall surface temperatures, the tube wall temperature drop, and the inside and outside tube wall surface temperature variation is less for a molten reactor fuel than for a solid fuel region. It is also found that in the limit of a vanishing Rayleigh number the temperature fields in a triangular tube bundle with a molten reactor fuel approach those found in tube bundles with a solid fuel region. (auth)

19373 (MIT-2073-2) A COMPUTER CODE FOR FUEL CYCLE CALCULATIONS IN A SPECTRAL SHIFT CONTROLLED, URANIUM FUELED REACTOR. Progress Report. Ferdinand Hofmann (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Sept. 1964. Contract AT(30-1)-2073. 53p. (MITNE-57). Dep.(mn); $3.00(cy), 1(mn) CFSTI.

A computer code for performing fuel cycle calculations in uranium-fueled, spectral shift controlled reactor is described. The principal features of the code include variable radial and axial mesh spacing, up to 5 radial and 4 axial zones, evaluation of the nuclear properties of the fuel as functions of both flux and time, a burnup subroutine using a third order Runge-Kutta technique, and a charge in the slowing down properties of the moderator with time. (C.E.S.)

19374 A METHOD OF EXAMINING FUEL ELEMENT FIN DEFORMATION. B. J. Darlaston (Central Electricity Generating Board, London). Nucl. Eng., 10: 62-3(Feb. 1965).

A method for assessing fin deformation under reactor conditions of gas flow, pressure, and temperature is described, together with the apparatus used. (D.C.W.)

19375 SELF-MODERATING FUEL ELEMENT. Joseph A. Dudek and Edward L. Reed (to U. S. Atomic Energy Commission). U. S. Patent 3,170,847. Feb. 23, 1965.

A self-moderating nuclear reactor fuel element and processes for its preparation are described. The fuel element comprises an electrically conductive core material encompassed by a layer of electrically conductive material with a radioactive element dispersed in it. The preferred embodiment is cylindrical in geometry and employs zirconium hydride as the central moderating core and copper impregnated with uranium dioxide as the layer of electrically conductive material. (AEC)

Power and Power-Breeder Reactors

Refer also to abstracts 18257 and 18434.

19376 (ACNP-64545) LA CROSSE BOILING WATER REACTOR FINAL PHYSICS DESIGN REPORT. M. P. Lowenfeld and M. F. Ross (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). May 1964. Contract AT(11-1)-654. 32p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The final physics design data for the La Crosse Boiling Water Reactor startup core are presented. Core multiplication constants, control rods, core coefficients, initial configuration and operation, power distribution, and fuel lifetime are discussed. (C.E.S.)

19377 (AECL-2155) SOME NUCLEAR CHARACTERISTICS OF NPD. C. E. Till and A. C. Whittier (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 21, 1963. 18p. Dep.; $0.50(AECL).

NPD is described briefly. The first approach to criticality was carried out by raising the moderator level and plotting $(1/\phi)$ vs a calculated k_{eff}. The moderator level was calibrated for use in reactivity measurements. The moderator temperature effect and coolant temperature effect on reactivity were less than expected. The power coefficient, booster rod worth, and H_2O reflector worth agree with calculation. The effect of fuel burnup on reactivity is less than expected. (auth)

19378 (AECL-2157) ZED-2 EXPERIMENTS WITH AN ENRICHED UO_2 FUEL BUNDLE IN AN NPD LATTICE. R. E. Green (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Dec. 1964. 33p. Dep.; $1.00(AECL).

Experiments were done in ZED-2 to determine the flux perturbations and reactivity effect produced in an NPD mockup lattice by a CANDU-type fuel bundle containing enriched UO_2(2.50 w/o U-235). The maximum thermal flux perturbations observed in the ZED-2 lattice were +18% at the surface of a neighboring fuel channel and +19% in an adjacent fuel bundle in the same fuel channel. A simple method, based on the ZED-2 measurements, is outlined for predicting the reactivity effect of a similar enriched UO_2 bundle in the NPD reactor. The method gives good agreement with the effects observed to date in NPD. (auth)

19379 (AECL-2205) NPD: AN ANNOTATED BIBLIOGRAPHY OF PUBLISHED LITERATURE. D. Radley and F. S. Armstrong (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1965. 19p. Dep.; $0.50 (AECL).

A list of 106 references to the Nuclear Power Demonstration station from its inception to Dec. 1, 1964 is given. (auth)

19380 (CEND-513) ADVANCED BONUS CORE DEVELOPMENT PROGRAM. Quarterly Progress Report No. 4, August–November 1964. J. F. Gibbons, R. L. Lyerly, W. A. Maxwell, K. E. Roach, and W. J. Mordarski (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Dec. 1964. Contract AT(40-1)-3154. 145p. Dep.(mn); $4.00(cy), 4(mn) CFSTI.

Research and development on the Bonus core is reported. Efforts to define the specific power and lower steam header arrangements for a design using solid multitube elements are discussed. The steam system and boiler cladding material were selected, and the fuel material and fabrication process were established. The reference design is based on the use of Inconel 625 cladding for boiler and superheated steam surfaces, and the use of pellet fuel. Welding

procedures for fabrication of the steam-tube to tube-sheet joints, the lap weld and the boiler-clad to tube-sheet joints were established. It is noted that the design of the reference fuel assembly permits substitution of Zircaloy-2 boiler cladding in the latter stages of development without any change in lattice spacing, pellet size, or steam tube arrangement. For this reason development work concerned with Zircaloy-2 was continued. Results of investigations of multitube fuel element vibratory compaction showed that the type for the Advanced Bonus Core can be processed to a UO_2 density of 85% of theoretical. Results of corrosion-aging tests on Inconel 625 indicate that yield strength and elongation seem to reach saturation before 2000 hr with little change thereafter. (J.R.D.)

19381 (EURAEC-1331) RESEARCH PROGRAM FOR THE GARIGLIANO NUCLEAR POWER PLANT. Report No. 3. (Societa Elettronucleare Nazionale, Rome (Italy)). Jan. 1, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 101-63-11-RD I. 10p. (EUR-2308). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Fabrication of the GE-412 computer was completed and shop tests were performed. Preparation of programs and program tests were continued on the GE-412 computer. Preliminary calculations were completed for high void tests. The control rod oscillator conceptual design was completed and the preliminary stability calculations under severe conditions were performed. (auth)

19382 (GEAP-4714) EVESR—NUCLEAR SUPERHEAT FUEL DEVELOPMENT PROJECT NINTH QUARTERLY REPORT, JUNE–AUGUST 1964. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct. 1964. Contract AT(04-3)-189. 115p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

The power testing program was completed after which the reactor operated at a steady-state power level of 12.5 Mw_t throughout the quarter except for short periods of shutdown. The time-operated efficiency was 83.3%, and the cumulative fuel exposure averaged 415 Mwd/t of U. Installation of the EVESR O_2 and H_2 injection system is essentially completed. Construction is 75% complete on tie-in of the PG&E (VBWR) turbine-generator to the EVESR system, and construction of the EVESR fuel storage building is complete. Hazards analyses revealed that AEC licensing action is required before Mark III fuel is inserted in EVESR. The request for insertion of Mark III fuel is being processed simultaneously with requests to increase the reactor power level from 12.5 to 17Mw_t, to increase the the peak clad temperature to 1350°F, and to increase the peak specific power to 33 kw/kg of UO_2. The EVESR Fuel Evaluation Instrumentation System was in use and performed well throughout the quarter. The instrument to measure and record the O_2 and H_2 content in the EVESR inlet steam was completed and installed at EVESR. EVESR coolant chemistry data relating to fuel performance were collected on a routine basis and stored in the DARE computer system. Fission gas release continued at a very low level, with no indication of a service failure of fuel cladding. Fabrication of the basic fuel handling and inspection equipment for examining fuel in the EVESR fuel storage pool was completed. Design of a cleanup loop for the pool water was resumed. The fabrication of 16 seven-rod clusters for the four Mark III fuel assemblies was completed. Fabrication of all bundle parts is complete and assembly of the bundles is going forward. Design of the Mark IV fuel assemblies is near completion, but is being reviewed in light of the expected increase in reactor power level. Cladding materials will be Incoloy-800, Inconel-625 and Hastelloy-X. Design of the Mark V fuel was initiated. A physics feasibility analysis was completed in connection with the proposed irradiation of Advanced BONUS Core fuel elements in EVESR. (auth)

19383 (GEAP-4768) DEVELOPMENT PROGRAM ON THE GARIGLIANO NUCLEAR REACTOR. Quarterly Report No. 9. C. L. Howard (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 40p. (EURAEC-1316) Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The programs for the on-line computer have been coded for the GE-412 computer, except for the 11 on-demand programs. About half the programs have been tested on a 412 computer. The computer hardward has been shipped to the reactor site. The long-delivery portions of the instrumented assembly flow and temperature instruments and electronics have been ordered. Detailed design of the remainder of the system is in progress. The evaluation of core power distributions after a plant uprating is continuing. The control rod pattern, power shape, and the ability to hold the power shape throughout the fuel lifetime are the most difficult problems in the core evaluation study. The on-line computer codes are being used to continue the study. Preliminary safeguards information for the reactor tests has been prepared and submitted to SENN for use in obtaining from CNEN approval for several temporary changes in the plant license. Stability analyses show that the Garigliano tests will result in valuable information, especially when the reactor is operated at low flow and high subcooling. Control rod drive equipment is being fabricated, and notches are being removed at three points on a space control rod drive index tube. The control and safety circuit for the rod oscillator is described. (auth)

19384 (HPR-42) CONTROL ROD EXPERIMENTS IN THE SECOND FUEL CHARGE OF HBWR. H. Smidt Olsen and R. Solheim (Institutt for Atomenergi, Halden Norway). OECD Halden Reaktor Prosjekt). Sept. 1964. 37p. Dep.(mn).

The large initial excess reactivity of HBWR has permitted critical measurements of the reactivity worth of a large number of control rods. Experiments have been performed in which the critical water height has been measured with groups of 6, 12, and 18 control rods inserted to various depths in the core. In all cases the rods were symmetrical with respect to the core axis. The transformation of critical water heights into reactivity was obtained by integrating the water level reactivity coefficient from the critical water level of the clean core to the water level as measured with the control rods inserted. The temperature dependence of the reactivity worth for a group of 6 control rods has been measured in the temperature interval 34 to 220°C. The experimental results have been compared with theoretical values obtained by two-group theory. The control rods are homogenized together with fuel and moderator so as to form a control rod zone characterized with a separate set of diffusion and absorption parameters. The epithermal absorption in the control rods is evaluated and it gives a contribution of approximately 7% in the reactivity worth of the rods. Comparison of the experimental and theoretical results shows that the calculations underestimate the effectiveness of the control rods. In most cases the differences range from 5 to 15%, but in a few unfavorable cases the discrepancy is as large as 28%. (auth)

19385 (HPR-46) OPERATING EXPERIENCE WITH HBWR ON ITS SECOND FUEL CHARGE. O. K. Bakken, J. A. Firing, E. Jamne, K. D. Knudsen, T. Wullum, and M. Oevreeide (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Nov. 1964. 67p. Dep.(mn).

The modification work, which was required for the second charge operation was completed in January 1962, and after a thorough commissioning period the reactor was made critical for the first time with the second fuel charge on 23rd March, 1962. A series of low power–low temperature experiments followed and included calibration of control rods, measurements of absolute thermal neutron flux, reactivity effects of experimental equipment, measurements of fast fission flux and measurement of flux peaking in fuel stringers. This experimental period was followed by a hot commissioning period, which included the final work of sealing and leak testing of the primary circuits. A series of low power–high temperature experiments was performed and comprised: calibration of control rods,

measurements of temperature reactivity effects, thermal flux measurements and static void measurements. The reactor was successfully brought to high power in October 1962. Since this time the plant has been operated at variable power levels up to 20 Mw. The power experiments included testing of four different instrumented fuel assemblies, xenon poisoning experiments, stream load variation experiments, reactivity perturbation experiments, transfer function measurements, flux and void measurements and noise measurements. A water chemistry program has been carried out with the purpose to study heavy water decomposition, suppression of gas formation by deuterium addition and pH control by ammonia addition under various reactor conditions. The reactor was operated on a three shift basis during all experiments, however, there have been frequent interruptions due to rearrangement of experimental equipment, preparation of new experiments, and to some extent for maintenance. A chronology of the operation is given. In general the plant has been operating satisfactorily. At the highest power levels the reactor proved, however, to be more sensitive to load changes than anticipated. This is due to flash boiling in the bulk moderator during transients when the steam load exceeds the nuclear power. There have been some equipment failures, however, they have in general been of such a nature that they did not cause significant delays. (auth)

19386 (HPR-48) CRITICALITY EXPERIMENTS WITH 24, 36 AND 100 ELEMENTS OF THE SECOND FUEL CHARGE OF HBWR. J. Davidson, R. Solheim, and V. Tosi (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Nov. 1964. 41p. Dep.(mn)

The critical size of three different cores, consisting of 24, 36, and 100 HBWR second charge fuel elements, has been determined. The measurements are compared with theoretical values, and while k_{eff} of the 24-element critical core is overestimated by 0.8%, k_{eff} for the 100-element critical core is underestimated by 0.1%. (auth)

19387 (HW-84440) EXAMINATION OF FLAWS IN PRTR ZIRCALOY-2 PRESSURE TUBES. M. C. Fraser (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 14, 1964. Contract AT(45-1)-1350. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Flaws have been observed with the in-reactor monitoring borescope on three separate PRTR Zircaloy-2 pressure tubes. Two have been examined macro- and microscopically after cutting the affected portion of metal from the discharged tube. One of these, tube 5526, was examined using an eddy current test device before cutting the tube for macro and microscopic examination of the flaw. The information from the eddy current device indicated the flaw was 7 ft 11 in. from the flange of the tube and that the flaw was less than $\frac{5}{8}$ inch long, less than $\frac{1}{4}$ inch wide and possibly as deep as 0.040 inch. Macroscopic examination indicated the size of the flaw was one-third inch long by one-sixteenth inch wide by one-sixty-fourth inch deep. This is about one-fifth to one-tenth of the size estimated using the eddy current test device. Application of this correlation to the eddy current test will improve the accuracy of the tests. The evidence collected indicates the flaws were cavities in the metal which had become longitudinally oriented by the tube fabricated processes. The flaws were formed in the metal prior to tube final inspection and insertion in the PRTR reactor. (auth)

19388 (MIT-2073-3) FUEL CYCLE CODE, "FUELMOVE III." Progress Report, J. A. Sovka and M. Benedict (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Sept. 1964. Contract AT(30-1)-2073. 42p. (MITNE-58). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Further modifications to the fuel cycle code FUELMOVE are described which were made in an attempt to obtain results for reflected reactors operated under batch, outin, and bidirectional fueling schemes. Numerical methods used to obtain solutions to the condensed two-group diffusion equation are presented. Results indicated that the method for obtaining solutions for the thermal flux distribution in reflected reactors using this condensed two-group formulation appears to be inadequate in certain cases in which the reactor is treated explicitly as a separate region. A recommendation is made for one additional evaluation of this technique with a further recommendation that subsequent studies of the fuel cycle behavior of reflected reactors be made using the full two-group diffusion formulation. (auth)

19389 (NP-14648) GARIGLIANO NUCLEAR POWER PLANT. (Società Elettronucleare Nazionale, Rome (Italy)). Sept. 30, 1964. 7p. Dep.(mn).

Operations, modifications, tests, and maintenance of the Garigliano Power Reactor, during the period from July to Oct. 1964 inclusive, are summarized. (T.F.H.)

19390 (NYO-2910-8) APPLICATIONS OF ULTRASONIC ENERGY. ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. Bimonthly Progress Report No. 20, December 1, 1964–January 31, 1965. (Aeroprojects, Inc., West Chester, Pa.). Feb. 1965. Contract AT(30-1)-2910. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The molten salt level detector was installed in the MSRE test loop and final proof tests were conducted. The tests showed a high degree of reliability and reproducibility of detection. Acoustic temperature measurement using a self-excited system was tested, and test data show a highly reproducible linear relation between temperature and the resonant frequency of the acoustic system. The use of auto-excitation as a means of instantaneous thermal compensation of other instruments is discussed. (auth)

19391 (ORNL-TM-984) THE REACTION OF STEAM WITH LARGE SPECIMENS OF GRAPHITE FOR THE EXPERIMENTAL GAS-COOLED REACTOR. R. E. Helms and F. E. MacPherson (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Carbon reaction rates and hydrogen generation rates have been determined for high-pressure, high-temperature steam flowing through a full scale EGCR fuel element graphite sleeve (Speer 901-RYL) and a geometrically identical sleeve machined from EGCR moderator graphite (National Carbon Company). Tests were made in the temperature range of 1200 to 1600°F with both graphite sleeves. To determine the effect of pressure from 30 to 300 psig, test data were obtained using an EGCR fuel element graphite sleeve. On both specimens, tests were also conducted at different steam flow rates. Exposure of the graphite to steam over a period of time roughens the surface thus increasing the reactive surface area. This burn-off of graphite results in an increase in the nominal reaction rate. The reaction rate of the EGCR fuel element sleeve graphite was 5.6 g/hr · ft^2 at 155 psig, 1600°F and approximately 4.0% burnoff. The reaction rate of the EGCR moderator graphite (National Carbon Company) was greater than the EGCR fuel element sleeve graphite (Speer 901-RYL) by a factor of 3.0 at 1600°F. No significant effects of pressure or steam flow rate were noted. The moderator graphite was exposed to 1550°F steam for 136 hr and 1580°F steam for 41 hr. After exposure to steam at these and lower temperatures for approximately 900 hr, the EGCR moderator graphite could be crumbled very easily. The EGCR fuel element graphite which appeared structurally sound after the test, was exposed to steam for a longer total time but only for 48 hr at a maximum temperature of 1580°F. (auth)

19392 (WCAP-6062) EXPERIENCE IN THE SHIPMENT OF YANKEE FUEL ASSEMBLIES FOR POST-IRRADIATION EXAMINATION. B. James, D. D. Payne, and H. E. Walchli (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Feb. 1965. Contract AT(30-1)-3017. 160p. Dep.; $5.00(cy), 3(mn) CFSTI.

Under the Yankee Core Evaluation Program, fifteen spent Yankee Core I fuel assemblies were shipped, starting early in 1963, from the Yankee reactor to the Westinghouse Post Irradiation Facility (WPIF) at Waltz Mill, Pennsylvania, for test and evaluation. An investigation was conducted of the feasibility and economics of several methods of shipment. The method of shipment selected was transport of a purchased single element cask by common carrier. Cask handling, decontamination, vehicle loading, general maintenance, and emergency services at both terminals and as required enroute were provided by a general contractor

with experience in this line of work. The knowledge and experience gained from these spent fuel shipments are presented. The equipment employed, the approvals required, and the technical and administrative problems that had to be resolved are discussed. Also, an analysis of the thermal characteristics of the spent fuel and the single element shipping cask is presented. (auth)

19393 BREEDER REACTORS. Lloyd G. Alexander (Oak Ridge National Lab., Tenn.). Ann. Rev. Nucl. Sci., 14: 287-322(1964).

Incentives for and policies on breeder development are summarized. The breeding process is analyzed, including the breeding ratio, fuel yield, power cost, and characteristics of the breeder complex. Fuel development, operating characteristics, present experiments, and future outlook for fast and thermal breeder reactors are reviewed. 154 references. (M.J.T.)

19394 THE FUEL BALANCES OF NUCLEAR ENERGY. G. Ritter and G. Blaesser (EURATOM, Ispra, Italy). Atomwirtschaft, 10: 86-91(Feb. 1965). (In German)

The view that, in considering the future role of a reactor type, not only its constructional characteristics but the total fuel balance of the system should be considered and compared with those of other systems is advocated. This includes the fuel charge, the possible necessity for reprocessing, isotope separation, residues in enriched material, and fission products. Four reactor types were investigated: the heavy-water, natural-uranium reactors (particularly ORGEL), light-water reactors (particularly pressurised water types), fast breeders (plutonium cycle), and the heavy-water, thorium converters (thorium cycle). Natural uranium, gas-graphite reactors and high-temperature thorium converters are regarded as similar to the heavy-water thorium converters and the heavy-water, natural-uranium converters, respectively, in respect of fuel balances were calculated in power station units and are therefore comparable one with another. The fast breeder and the thorium converter were, from the standpoint of raw material supply, found to be best for power station reactors for the distant future. From the point of view of fuel the difference in the order of magnitude of the respective fuel charges and fuel utilization as compared with the breeder and the converter is clear. (auth)

19395 OPERATING EXPERIENCE WITH PRESSURIZED WATER REACTORS. M. Bonanni (Westinghouse International Atomic Power Co., Ltd., Ghent). Atomwirtschaft, 10: 92-5(Feb. 1965). (In German)

The experience gained with pressurized-water reactors is discussed. As the first large PWR for commercial operation the Yankee Reactor started generating power in November 1960. The stability of the control rods was excellent; however wear and tear on their coupling to the drive made changes in construction and materials necessary. Experiments in the Yankee and Saxton reactors formed the basis for the development of the chemical shim to a regular method of control. It is now being applied in the Indian Point, SELNI, and SENA reactors and to other installations on order. The fuel elements were successful. Operating experience in Yankee showed that commercially available stainless steel is fully suitable as a cladding material in pressurized-water reactors. Individual elements were subjected to burnups of up to 30,000 Mwd/t without perceptible damage to the cladding. In the case of zirconium alloys, Zircaloy-4, because of its lower hydrogen absorption, gave a longer cladding life than Zircaloy-2. Experience was also gained with individual installation parts such as the turbines, steam generators, encapsulated primary pumps, etc. Yankee was licensed for three successive increases in capacity, from 120 to 150, 170, and finally 185 Mw(e) all of which were obtained without additional capital expenditure. By advanced design power densities of 85 kw/l of core volume could be obtained leading to a reduction in size of the pressure vessel while on the other hand, improvements in manufacturing techniques made possible vessels of very large dimensions. Economies in capital costs were obtained by standardization of installation parts and the planned elimination of such parts led to simplification. This also led to a reduction in the time needed for exchange of fuel. Rod cluster control, in addition to chemical shim, offers new possibilities of control. Further progress resulted from the arrangement of fuel in zones by appropriate fuel exchange systems. The so-called "roundelay-cycling" method of fuel insertion is being developed for reactor cores of very large dimensions and higher burnup capacities. (auth)

19396 POSSIBILITIES OF DEVELOPMENT IN ENERGETIC REACTORS WITH GAS COOLING. PART I. Istvan Szantho. Energia Atomtech., 17: 525-33(1964). (In Rumanian)

The economic considerations of the use of gas as cooling medium are reviewed on the basis of the operational experience of the Calder Hall type power stations. Gas cooling offers, among others, the following advantages: a negative temperature coefficient, resulting in inherent safety; no change in the state of aggregation of the coolant, eliminating the danger of the boiler-explosion type accidents; possibility of using natural U; high conversion factor, allowing to produce valuable fission ^{239}Pu; possibility to take advantage of superheating; use of inexpensive coolants, such as CO_2; low corrosivity of the usual coolants; convenient reloading during operation; and possibility of using a gas turbine in the coolant system without an intermediate heat exchanger, thus increasing the thermal efficiency. Among the unfavorable factors, it is mentioned that the specific weight and specific heat of the gases are low, requiring the circulation of large volumes; their heat transfer coefficient is poor, necessitating the use of large cooling surfaces; the gas flow must overcome a large resistance at considerable expense; the secondary heat exchanger must have relatively large dimensions and the graphite moderator must be of high purity. The following approaches appear desirable for further development: use of enriched-U, ceramic fuel elements; increase of the gas pressure; stepping up the heating of the coolant within the reactor; use of prestressed concrete reactor vessels; and further study of the properties of CO_2 and of He and the development of economical gas-turbine circuits. (TTT)

19397 POSSIBILITIES OF DEVELOPMENT IN ENERGETIC REACTORS WITH GAS COOLING. PART II. Istvan Szantho. Energia Atomtech., 17: 572-83(1964). (In Rumanian)

After reviewing the potential methods that may be applied in the further development of the current gas-cooled reactor types, four operating systems are discussed in detail. They include: the CO_2-cooled AGR, representing the second generation of the British power reactors designed for an operating life of 20 years; the He-cooled, 20-Mw Dragon reactor, designed for research rather than for actual power generation; the American HTGR, illustrating the U. S. approach toward a high-temperature system, and the AVR at Julich, West Germany, featuring graphite-coated spherical UC_2 fuel elements, cooled by He. After examination of the long-range expectations of gas-cooled reactor systems, it is concluded that the currently available data are insufficient to decide which of the approaches is the most promising. On the basis of the continued large-scale financial support by the interested sponsors, it can be stated that gas-cooled reactors are economically competitive. The British experience will probably soon provide the economic data needed for reliable forecasts. (TTT)

19398 UTILIZATION OF PLUTONIUM IN THE UNITED KINGDOM. H. Kronberger (United Kingdom Atomic Energy Authority, Windscale, Cumb., Eng.) and N. L. Franklin. J. Brit. Nucl. Energy Soc., 4: 37-44(Jan. 1965).

Assuming the installation of 5000 Mw(e) of AGRs in addition to the present program of 5000 Mw(e) of magnox reactors, about 20 tons of plutonium will be produced in the UK by 1976. The UKAEA studied the effect of its use both in fast and thermal reactors. Experimental plutonium-bearing fuel was used in the Windscale AGR since January, 1964. The reactor physics problems in thermal and fast reactors were compared and the value of plutonium to

individual reactor systems was assessed. The developments in physics and metallurgy showed that plutonium fuel can be used in thermal and in fast reactors, but that if fast reactors continue to be promising, then plutonium will be a more valuable fuel in fast reactors that in thermal reactors. (auth)

19399 INDIAN POINT NUCLEAR POWER STATION—THE FIRST TWO YEARS' OPERATION. J. C. Deddens (Babcock and Wilcox Co., Lynchburg, Va.) and R. H. Freyberg. J. Brit. Nucl. Energy Soc., 4: 45-55(Jan. 1965).

Reactor startup and operations test programs in the Indian Point Power Reactor are discussed. Zero power experiments, precritical testing, zero power physics testing, testing at power, and plant dynamics tests of controls are described. Calibration of neutron detector channels and the gamma scan program are discussed. Failures and corrections of plant systems and components and radiochemistry in the system are considered. Operating experience is summarized. (M.C.G.)

19400 OPERATING EXPERIENCE WITH THE KAHL NUCLEAR POWER STATION. August Weckesser (Versuchsatomkraftwerk Kahl GmbH, Ger.). J. Brit. Nucl. Energy Soc., 4: 56-65(Jan. 1965).

Design of the Kahl 15000 kw(e) nuclear power station, consisting of an indirect-cycle boiling-water reactor with a conventional secondary steam turbine generator system, is described. The power plant produces 60.4 Mw(t) and 16Mw(e) gross and the average fuel burnup hitherto attained is 7500 Mwd/metric ton uranium. Reactor startup experience, plant availability, scheduled and unscheduled plant shutdowns, the off-gas system, environmental release of activity, radiation survey, fuel performance, and installation and operation of a nuclear superheat test loop are discussed. (M.C.G.)

19401 THE PERFORMANCE OF URANIUM–MAGNOX FUEL ELEMENTS DURING THE FIRST 18 MONTHS' OPERATION OF THE BERKELEY AND BRADWELL REACTORS. G. F. Hines and A. G. Uglow (Central Electricity Generating Board, Bristol, Eng.). J. Brit. Nucl. Energy Soc., 4: 66-74(Jan. 1965).

Examination of CEGB fuel elements after an irradiation of approximately one-quarter of the full lifetime confirmed their ability to withstand the reactor environment without marked deterioration of structural or heat transfer properties. The deformations noted on the Berkeley fuel elements generally confirmed predictions from rig tests and irradiation trials of prototype elements. In the case of Bradwell fuel elements effects attributable to the gas forces were slight. The chief deformations occurred over the bottom elements in the channels as a result of radioinduced deformation of the uranium bar. A small number of fuel element failures occurred without causing any reactor damage although some of them necessitated unscheduled shutdowns. Post-irradiation assessments of leak sizes on potential failures indicated the limitations of the pressure-step technique, although other methods of leak testing the fuel charge after loading into the reactor showed some promise. The results so far obtained from post-irradiation examination gave confidence in the use of uranium–magnox fuel elements in the present reactors and in the more highly rated reactors at present under construction. (auth)

19402 EXPERIMENTS IN POWER REACTORS. B. Koehler (VEB Atomkraftwerk, Berlin). Kernenergie, 7: 797-811(Dec. 1964). (In German)

A survey is presented of experiments conducted in power reactors. Specific instances of startup, operation control and optimization, and components testing are given. (R.E.U.)

19403 ON POWER REACTOR EVALUATION. Ryukichi Imai (Japan Atomic Power Co., Tokyo). Nucl. Eng., 10: 46-8(Feb. 1965).

Criteria for evaluation of power reactors are outlined; and uncertainties in cost calculations, construction costs, fuel costs, and warranties are discussed with reference to specific installations. (D.C.W.)

19404 NUCLEAR POWER ECONOMICS. (International Atomic Energy Agency, Vienna (Austria)). Bibliographical Series. Dec. 1964. 156p. STI/PUB/21/13. $3.00; S 63,-18/-stg; F. Fr. 12,-; DM 10.50 (IAEA).

A total of 771 references, almost all with abstracts, is given to the literature published and/or abstracted during the period 1960-1963. The references are arranged into six sections dealing with general aspects, evaluation of power reactors, nuclear propulsion, water desalination, reactor materials, and other economic aspects. An author index is included. (D.L.C.)

19405 STEAM GENERATOR. Ben Blumberg, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,170,846. May 6, 1965.

A nuclear steam generator is described, which comprises a gas-cooled reactor and a once-through boiler heated by the hot gas from the reactor. The reactor and boiler are in a compact arrangement with the reactor located above the boiler. The gas is circulated in a closed cycle through the reactor and boiler by a pump. Superheated steam is produced by the boiler. (AEC)

Propulsion and Space

See also ENGINEERING — Space Propulsion.

Refer also to abstract 18119.

19406 (APEX-509) SUMMARY REPORT OF HTRE NO. 3 NUCLEAR EXCURSION. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). [nd]. Contracts AF33(600)-38062 and AT(11-1)-171. 148p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

A power excursion and fuel element meltdown in the HTRE No. 3 prototype aircraft power plant are discussed. The cause of the power excursion, safety actions, and the mechanism of reactor shutdown are considered. (C.E.S.)

19407 (BMI-X-10109) IRRADIATION OF SNAP SYSTEM ACTUATOR AND POSITION SENSOR ASSEMBLIES IN A VACUUM-NUCLEAR ENVIRONMENT. Sam J. Basham, William G. Rieder, William J. Zielenbach, H. Thomas Gruber, and Joseph P. Allgeiger (Battelle Memorial Inst., Columbus, Ohio). Feb. 10, 1965. Contract [W-7405-eng-92]. 41p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Two actuator and position sensor devices were irradiated to an integrated fast-neutron exposure of 2 and 4×10^{18} n/cm^2 in a high-vacuum environment (10^{-5} torr) at temperatures of 500 to 700°F to obtain radiation-effects data for the SNAP program. Detailed measurements of the nuclear environment were made to aid in the study of radiation damage of the specimens. Temperatures and vacuum levels were monitored continuously. Actuator operational performance was monitored periodically as were the characteristics of components (insulation resistance, resistance, impedance) to establish degradation rates and damage thresholds. (auth)

19408 (NAA-SR-9885) DEVELOPMENT, FABRICATION AND TESTING OF HONEY-COMB RADIATOR CONDENSER. G. Scott and W. Engle (Atomics International, Canoga Park, Calif.). Mar. 1, 1965. Contract AT(11-1)-Gen-8. 53p. Dep.; $3.00(cy), 1(mn) CFSTI.

The development, fabrication, and testing of the SNAP Mercury Rankine (SNAP 2) prototype design steel-honeycomb radiator-condenser is summarized. The discussion includes a description of the basic design, the principal elements of this design, the development required to produce the full-size units, and the test program conducted with both radiator-condenser components and assemblies. (auth)

19409 (NAA-SR-9894) DEVELOPMENT OF HIGH-TEMPERATURE ELECTRICAL GROUND TEST HEATERS FOR THE SNAP-10A PROGRAM. R. Blevitt, G. Paine, and S. Sudar (Atomics International, Canoga Park, Calif.).

Mar. 1, 1965. Contract AT-11-1-GEN-8. 128p. Dep.; $2.50(cy), 3(mn) CFSTI.

Ground test heaters are required to provide thermal power to the SNAP 10A nuclear power units (NPU), for acceptance testing of the NPU prior to customer delivery and for qualification test systems utilizing non-nuclear power. Electrical heaters have been developed to meet all system requirements for the acceptance test heaters and reactor simulator heaters. The nominal steady-state power level is 40 kwt. The heater development is described. Two types of acceptance test heaters were developed, a conduction type permanently bonded to the 10A NaK coolant system, and a radiant type that can be removed upon completion of system checkout. The radiant type satisfied the system requirement of essentially zero weight penalty for an acceptance test heater; it utilizes tantalum ribbon elements and beryllia insulators, operating in a 10×10^{-2} Torr environment. Both heater designs have been fabricated and have passed stringent qualification tests. Component deliveries of the conduction type have been made to the 10A-FS1 test system. All other 10A systems, including flight systems, will utilize the radiant heater; fabrication of system units is now in progress. (auth)

19410 (NASA-CR-54219) SNAP-8 ELECTRICAL GENERATING SYSTEM DEVELOPMENT PROGRAM. Quarterly Report No. 0390-04-17. (Aerojet-General Corp., Azusa, Calif.). Oct. 1964. Contract NAS-5-417. 213p.

The objective of the SNAP-8 Program is to design and develop a 35-kw electric generating system for use in various space emissions. The progress during the seventeenth quarter of contract performance is reported. The status of the various necessary systems analyses is presented. Design and fabrication of components—turbine alternator assembly, NaK and mercury pump-motor assemblies, bearings, seals-to-space, mercury boiler and condenser, mercury injection system, electric insulation, and electrical components—are reported. Testing the several component test loops is discussed. Materials evaluation of components exposed to mercury corrosion and erosion is presented. (auth)

19411 ECONOMIC PROSPECTS FOR NUCLEAR POWERED MERCHANT SHIPS. M. von zur Muehlen (Gesellschaft fur Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Hamburg). Atomwirtschaft, 10: 66-9 (Feb. 1965). (In German)

The economic prospects for nuclear-powered merchant ships can only be estimated because there is still a lack of sufficient operating experience and of detailed calculations in all the cost fields. The costs, which in general can be expected to differ from those of conventionally powered ships, were determined. Costs of the reactor installation are discussed. It was concluded that even if further development and lowering of excessive safety requirements makes further price decreases possible the cost of a reactor installation must exceed that of a conventional boiler plant for the foreseeable future. However lower fuel costs are to be expected for nuclear-powered ships than for conventional ships. The fuel costs of a conventional plant, which is considered most economical from the point of view of fuel, the heavy oil diesel engine are compared with the calculated fuel costs of the German nuclear-powered merchant ship, "Otto Hahn," due to go into operation in 1967. By contrast the cost differences between nuclear and conventionally powered ships were found to be less significant in respect to crew, insurance, harbor dues, repairs, etc. The questions of weight and savings in space play a different role according to the kind and use of the ship under consideration. The investigation showed that nuclear propulsion could be economically interesting in the foreseeable future for large bulk freighters or tankers, which operate with a high load factor for the machinery and with high pay loads over long hauls. There was not considered to be sufficient data to judge the prospects of nuclear propulsion for passenger ships. (auth)

19412 NUCLEAR SAFETY IN SPACE APPLICATIONS. L. R. Shepherd. New Scientist, 25: 142-3(Jan. 21, 1965).

Various experiments and results related to nuclear safety, including the Kiwi destruct-test, are discussed. (R.E.U.)

Research and Test Reactors

Refer also to abstracts 17831, 17832, and 18259.

19413 (BNL-8802) EXPERIMENTAL EQUIPMENT AND METHODS FOR INELASTIC NEUTRON SCATTERING MEASUREMENTS. H. Palevsky (Brookhaven National Lab., Upton, N. Y.). [Dec. 1964]. Contract [AT(30-2)-Gen-16]. 50p. (CONF-804-25) Dep.(mn); $2.00(cy), 2(mn) CFSTI.

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

The Brookhaven High Flux Beam Reactor and associated equipment to be used for inelastic neutron scattering measurements are discussed. The neutron beam holes, chopper monochromators, neutron detection equipment, and data handling systems are described. (C.E.S.)

19414 (CONF-641009-9) INPILE TEST LOOP AT THE PLUM BROOK REACTOR FACILITY. S. S. Stein (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). [1964]. Contract [SNP-1]. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

Westinghouse has designed several test facilities which will provide the capability for pre-irradiation and irradiation testing of structural materials, electrical and mechanical components and instruments, in environments from 50 R to ambient. A water-cooled loop (W-2) is now in operation, providing an ambient environment for experiments inserted in the reactor through tube, HT-1, and it is presently contemplated that a cryogenic helium-cooled loop will be incorporated for experiment temperatures as low as 50°R. Irradiation of components in this location provides high neutron and gamma fluxes to simulate those encountered by components during the NRX (Nuclear Reactor Experiment) test program. The water-cooled loop consisting of a capsule assembly containing the experiment, handling equipment, and coolant piping will also serve as a pilot facility for the 20 kw-50 R cryogenic loop. A laboratory mock-up loop provides the nonradiation environment required in support of the experiments. (auth)

19415 (CRC-1210) METHODS OF DOSIMETRY AND FLUX MEASUREMENT AND THEIR APPLICATION IN THE NRX REACTOR. A. W. Boyd, H. W. J. Connor, and J. J. Pieroni (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1965. 69p. (AECL-2203). Dep.; $1.50(AECL).

Energy deposition rates in the NRX reactor were determined using calorimeters, graphite-CO_2 ion chambers, and the radiolytic hydrogen yield from cyclohexane. The values from the three methods are in good agreement. Two types of calorimeters and the ion chamber are described, circuits and saturation curves for the ion chamber are given, and the dependence of the cyclohexane hydrogen yield upon dose rate and dose is shown. Thermal neutron fluxes were determined with cobalt (37 b), fast fluxes using the $^{58}Ni(n,p)^{58}Co$ reaction (90 mb). (auth)

19416 (IS-1012) TRANSIT TIMES AND ELECTRICAL DISCHARGE IN A STEADY-STATE GAS ACTIVATION SYSTEM. David Thomas and Willard L. Talbert (Ames Lab., Iowa State Univ. of Science and Tech.). Nov. 1964. Contract W-7405-eng-82. 72p. Dep.; $3.00(cy), 2(mn), CFSTI.

The problem of transporting a gas from the core of the Ames Laboratory Research Reactor to the ion source of an electromagnetic isotope separator in a steady-state fashion is considered. The parameters on which this flow depends are ascertained so that the flow may be predictably controlled by a computer. The transit time through the activation line is calculated and confirmed experimentally for nitrogen and xenon. The initiation of an

electrical discharge in the low pressure gas by a 60-kv potential is studied as a function of the gas and the gradient length. (auth)

19417 (ORNL-3759) DETERMINATION OF THERMAL-NEUTRON FLUX DISTRIBUTIONS IN THE BULK SHIELDING REACTOR II BY COPPER WIRE ACTIVATION TECHNIQUES. G. T. Chapman (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 53p. Dep.; $3.00(cy), 2(mn) CFSTI.

The thermal-neutron flux distribution within the ORNL stainless steel Bulk Shielding Reactor II has been determined by exposing copper wires at selected locations in the core during reactor operation. The gamma activity resulting from thermal-neutron activation of the copper was counted as a function of position along the wire, and the results converted to estimates of thermal-neutron flux. The method of analysis was checked by independently exposing gold and copper wires at a common location in the reactor. The thermal-neutron fluxes obtained from analysis of both sets of data were in agreement within ~3%. The method was further checked by comparing the results of a wire exposure with calculations of the distribution made by the PDQ reactor code. Agreement was good in statistically important regions. Several CDC-1604A programs were written to facilitate processing of the wire data. (auth)

19418 (UCLA-NEL-2) UCLA TRAINING REACTOR HAZARDS ANALYSIS. Final Report. Report No. 60-18. R. D. MacLain (California Univ., Los Angeles. Dept. of Engineering). Mar. 1, 1960. 103p. (DOCKET-50-142). Dep.(mn); $4.00(cy), 2(mn) CFSTI.

The safety aspects of the site and building of the UCLA Training Reactor are outlined. Descriptions are presented of the reactor, the checkout and operation procedures, and the hazards evaluation for the reactor. (T.F.H.)

19419 PURIFICATION OF WATER IN THE PRIMARY CIRCUIT OF THE IRT-1000 REACTOR— SOFIA AND CONTROL OF ITS QUALITY. K. Nikolov and R. Georgiev. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 11: 193-9(1963). (In Russian)

The steps taken to fill the primary circuit disk of the IRT-1000 reactor in Sofia with high-quality distillate are outlined. The results of the quality test are given, and it is pointed out that the pH electric conductivity, dry residue and content of iron, aluminium, ammonium and chlorine correspond to the norms recommended for the operation of the Soviet research reactors. Data about the effectiveness of the work done by the ion-exchange filters and about the first visual signs of corrosion in the primary circuit are also presented. (auth)

19420 NEUTRON FLUX AND RADIATION FIELD OF THE IRT-1000 REACTOR—SOFIA. V. Hristov, D. Damyanov, and A. Stanolov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 11: 201-20(1963). (In Russian)

The results are presented of absolute measurements of the thermal, resonance and fast (E > 1 Mev) neutron currents in the active zone and experimental channels of the IRT-1000 reactor. The measurements were made by means of irradiated gold and indium plates and with threshold detectors (^{32}S, ^{31}P, ^{24}Mg, ^{24}Na, and ^{27}M) for the fast neutrons, by the method of the 2π, the devices of which were calibrated by means of a 4π plant, which secures precision higher than 5%. Control measurements were also carried out by the method of beta-gamma coincidences. The results show good reproducibility. Absolute and relative measurements of the doses of mixed neutron-gamma fields at different points of the reactor were made by means of Grey chambers (polystyrene with acetylene and graphite with argon). By means of these chambers the absolute doses of the gamma field in the reactor stopped after having worked under various regimes were also measured. With the help of an automatic recording set, the distribution of slow neutrons in the active zone of the reactor was measured by the copper wires irradiated there, and the coefficient of the volume irregularity of the distribution was determined. Relative measurements of the distribution of F_{th} F_{res} , F_r and D_r in several experimental channels of the reactor were also made. (auth)

19421 RESULTS OF THE CONTROL OVER THE PURITY OF WATER IN THE FIRST CIRCULATORY RING OF THE IRT-1000 ATOMIC REACTOR IN SOFIA. K. Nikolov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 12: 121-6 (1964). (In Russian)

The methods and results of a two-year control over the water in the first circulatory ring of the IRT-1000 reactor in Sofia are discussed. The following parameters were recorded: pH, electric conductivity, dry residue, iron, chlorine, aluminum content. Their values are very close to the standards already advised by other writers. Data are cited of the spectrum analysis of the distillate dry residue. An explanation is also attempted on the origin of the different components that were found. (auth)

19422 RESEARCH IN CERTAIN KINETIC CHARACTERISTICS OF THE REACTOR IN SOFIA BY THE REACTOR OSCILLATOR METHOD. V. Christov, N. Bachvarov, and A. Markov. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 12: 127-36(1964). (In Russian)

Two kinetic parameters of the IRT reactor in Sofia were determined: the effective participation of delayed neutrons β^* and the average span of life of prompt fission neutrons in the active zone of the IRT reactor. An improved oscillating method was used. A small, hollow, compensated coaxial boron ionization chamber was used to detect the signal result, which permitted performance of the oscillation of the model in one and a same channel of the active zone, in close proximity of the detector (below and above the latter), improving the sensitivity of the measuring method. Using the l and β^* values determined experimentally, the reactor's amplitude curves and phase-frequency characteristics were calculated. A correction of the reactor's reaction curve was also introduced. (auth)

19423 CONSORT II RESEARCH AND TRAINING REACTOR. J. W. Borrer (General Electric Co., Ltd., Wembley, Eng.) and T. E. Hussey. Nucl. Eng., 10: 53-7(Feb. 1965).

The 100-kw pool-type reactor is described, with specific consideration of the control system, experimental facilities, ventilation, and water treatment circuits, and instrumentation. (D.C.W.)

19424 QUEEN MARY COLLEGE CRITICAL ASSEMBLY. W. K. Mansfield and J. Shaw (Queen Mary Coll., London and London Univ.). Nucl. Eng., 10: 58-61(Feb. 1965).

The graphite-reflected water-moderator assembly, which uses Al–U fuel plates, is described; and the commissioning measurements made on the assembly are outlined. The assembly will be used to study perturbation techniques for the measurement of steady and transient reactor system parameters and to study water-moderated lattices. (D.C.W.)

WASTE DISPOSAL AND PROCESSING

See also BIOLOGY AND MEDICINE — Ecology.
CHEMISTRY — Radiochemistry.
CHEMISTRY — Separation Processes and Procedures.
HEALTH AND SAFETY.

Refer also to abstracts 18052, 18065, and 18555.

19425 (HW-80814) RECOVERY OF AMMONIUM CARBONATE FROM CESIUM ION EXCHANGE ELUATES. W. J. Van Slyke (Hanford Atomic Products Operation, Richland, Wash.). Feb. 12, 1964. Contract AT(45-1)-1350. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Pilot plant studies on the recovery of volatilized ammonium carbonate and ammonia are reported. The pilot equipment was scaled to about three percent of the expected full capacity. The experiments performed showed that the full-scale design will be much smaller than anticipated and most of the absorption can be accomplished with a suitable condenser. (D.L.C.)

19426 (HW-84105) REMOVAL OF CESIUM FROM REDOX ALKALINE SUPERNATANT WASTES BY ION EXCHANGE. K. C. Knoll (Hanford Atomic Products Operation, Richland, Wash.). Oct. 1, 1964. Contract AT(45-1)-1350. 16p. Dep.(mn); $1.00(cy), $(mn) CFSTI.

A flow sheet was developed for separating cesium from Redox alkaline waste supernate which uses Duolite C-3 resin as an ion exchange material. The waste is diluted with three parts of water and loaded onto the resin column at 25C, at a flow rate of 2 column volumes an hour. The column is washed with water to remove all waste solution and the cesium is then eluted from the resin with 3N $(NH_4)_2CO_3 \cdot 1N\ NH_4OH$. The resin is regenerated in the column with sodium hydroxide which also increases the pH of the bed to prevent aluminum hydroxide precipitation upon further contact with the waste. The resin is then ready for reloading. This flow sheet worked successfully with synthetic waste and with supernate from the Redox 115-SX tank. The radiation stability of the C-3 resin was measured by loading a sample with about 5 curies of ^{137}Cs. After 14 days the cesium was eluted and the irradiated resin, along with a control resin column, was loaded with ^{137}Cs. About 15 percent loss of capacity was observed for the test column. The radioactivity to which the resin in the test column was exposed was greater than that to which it would be subjected in plant practice by a factor of 3000. (auth)

19427 (RL-SEP-65) CHEMICAL PROCESSING DEPARTMENT HAZARDS EVALUATION. IN-TANK WASTE SOLIDIFICATION PROJECT CAC-965. G. E. Backman, E. M. Johnston, H. C. Rathvon, L. V. Roddy, and M. F. Wiitala (Hanford Atomic Products Operation, Richland, Wash.). Nov. 24, 1964. Contract AT(45-1)-1350. 27p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The in-tank solidification unit, installed in an underground storage tank, is designed to concentrate high-salt wastes by hot-air sparges. A study was made of safety considerations in the process, design, and operating plans It is concluded that the unit is basically adequate for its intended use. Some additional measures for the control o possible hazards are recommended. (D.L.C.)

19428 (SZS-2) MATERIALIEN DER JAHRESTAGUNG DES DEUTSCHPOLNISCHEN ARBEITSKREISES ZU PROBLEMEN DER ERFASSUNG, DES TRANSPORTS, DER BEARBEITUNG UND DER ENDGULTIGEN BESEITIGUNG RADIOAKTIVER ABFÄLLE. (Materials from the Yearly Meeting of the German-Polish Working Group for Problems of Fixation, Transport, Processing, and Final Disposal of Radioactive Waste). (Staatliche Zentrale für Strahlenschutz, Berlin (East German)). June 1964. 47p. Dep.(mn)

The problems encountered in Poland, the USSR, Hungary, Bulgaria, and East Germany on the collection, transport, processing, disposal of radioactive waste and the solutions adopted are reported in the papers presented at the annual meeting. (J.S.R.)

19429 (AEC-tr-6544) GEOLOGICAL REPORT ON THE SUITABILITY OF MINE CAVITIES IN THE ASSE II ROCK SALT MINE FOR THE DISPOSAL OF RADIOACTIVE WASTES. E. Hofrichter (Bundesanstalt für Bodenforschung, Hanover (West Germany)). Translated from report, File No. 3278/63. Nov. 26, 1963. 13p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

The geological features of the Asse I, II, and III mines of the Burbach Kaliwerke AG. are described. The mine spaces and working spaces in Asse II are discussed, and its pressure phenomena and hydro-geological situation are described. The applicability of the cavities to storage of radioactive wastes is discussed in detail. The question of long-term stability is considered. (D.L.C.)

GENERAL AND MISCELLANEOUS

19430 (BNL-893) CHEMICAL-BIOCHEMICAL SIGNAL AND NOISE—RESOLUTION AT LOW TEMPERATURES. Simon Freed (Brookhaven National Lab., Upton, N. Y.). Sept. 23, 1964. Contract [AT(30-2)-Gen-16]. 15p. Dep. $1.00(cy), 1(mn) CFSTI.

Brookhaven Lecture Series No. 39.

A reduction in temperature of a chemical system effects a redistribution of the molecules from higher to lower energy states so that practically all the molecules occupy fewer states. At the same time they are exposed to fewer kinds of random, fluctuating perturbations from the environment such as a solvent. Since molecules in each state have precise properties except for the diffuseness induced by the perturbations, a sharpening in the magnitudes of properties relative to background has been acquired at low temperatures. As examples, behaviors of solutions are described which range in complexity of solute from inorganic salt to enzyme, of solvent from nonpolar to strongly polar, and in scale of temperature from about +25°C to −200°C, in some instances. The discussion includes the following features: discreteness of information, specificity, resolution of properties according to energy states of a pure substance, resolution of properties of different substances, resolution of reactions into intermediate reactions, equilibria among intermediates, avoidance of irreversibilities, properties of substances in excited states with mineral perturbations, and sensitivities of qualitative and quantitative analyses at low temperatures. Some anticipated applications to medical sciences are briefly indicated. (auth)

19431 (CONF-630803-1) INVESTIGATIONS ON THE EARLY EFFECTS OF CCl_4 ON LIPID TRANSPORT. M. Poggi, R. Fumagalli, A. Sabatini-Pellegrini, and R. Paoletti (Milan Univ. (Italy). Istituto di Farmacologia e di Terapia). [1963]. Contract AT(30-1)-3097. 17p. Dep.(mn). $1.00(cy), 1(mn) CFSTI.

From 2nd International Pharmacological Meeting, Prague.

Results are reported from studies on the role of catecholamines and of the adrenocortical hormones in the development of hepatic lesions and fatty infiltration of the liver of rats and rabbits after CCl_4 treatment. The results suggest that CCl_4 may have a direct role on liver lipid transport. Possible mechanisms are discussed. (C.H.)

19432 (COO-314-11) AROMATIC BORONIC ACIDS. SYNTHESIS OF o-BORONOPHENYLALANINE. J. R. Kuszewski, W. J. Lennarz, and H. R. Snyder (Noyes Lab. of Chemistry, Univ. of Illinois, Urbana). [1961]. Contract AT(11-1)-314. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Syntheses of N-acetyl-o-boronophenylalanine, α-amino-o-boronobenzylmalonic anhydride and o-boronophenylalanine anhydride are described. Alkylation of diethyl acetamidonmalonate with o-(bromomethyl)-benzeneboronic anhydride yields o-(2-carbethoxy-2-acetamidoethyl)-benzeneboronic acid rather than the expected o-(2,2-dicarbethoxy-2-acetamidoethyl)-benzeneboronic acid. Decarbethoxylation is explained by postulating that the boronic acid function participates in ester hydrolysis. Decarboxylation of α-amino-o-boronobenzylmalonic anhydride requires an unusually high temperature; this observation is interpreted in terms of a bridged, polycyclic structure. The decarboxylation product, o-boronophenylalanine anhydride, does not possess a zwitterionic structure; this fact indicates that interaction between the amino group and the boron atom occurs. (auth)

19433 (LA-3089) LARGE EXPLOSIVE-DRIVEN PLYWOOD SHOCK TUBES. John W. Taylor, with Section V by Richard Gentry (Los Alamos Scientific Lab., Univ. of California, N. Mex.). May 1964. Contract W-7405-eng-36. 97p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Certain problems in reentry vehicle design require testing by plane shock waves in air having amplitudes up to several hundred atmospheres (several thousand psi). Various considerations make the use of scale models undesirable, with the consequence that if the testing is to be done with gas shocks, the lateral extent of the plane shock front must be several feet and the time duration of the positive pressure pulse must be of the order of ½ to 1 msec. Some rather elementary considerations show that any permanent facility capable of doing this job would quickly become almost prohibitively expensive and would, in any case, require very long lead times. A relatively cheap, expendable facility is described, which has the advantages of simplicity, versatility, convenience for diagnostic measurements, and adaptability for use in any locality where large quantities of high explosive can be detonated. (auth)

19434 (LA-3137) SMOOTHING AND MULTIVARIABLE INTERPOLATION WITH SPLINES. T. L. Jordan (Los Alamos Scientific Lab., Univ. of California, N. Mex.). June 1, 1964. Contract W-7405-eng-36. 19p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

This paper gives the mathematical basis for smoothing and two-dimensional interpolation procedures in use at Los Alamos on the IBM 7094 and 7030 computers. The one-dimensional spline is redefined in a new and concise notation that extends to the two dimensional case. A smoothing procedure using splines, and which is of class C^2, is presented. A general extension to higher-dimensional interpolation as an extension of the procedure for two dimensional interpolation is outlined. (auth)

19435 (LA-DC-6413) TETRAMETHYLLEAD: FAR INFRARED SPECTRA, MOLECULAR VIBRATIONS, AND CHEMICAL THERMODYNAMIC PROPERTIES. RESOLUTION OF AN ENTROPY DISCREPANCY. G. A. Crowder, G. Gorin (Oklahoma State Univ., Stillwater. Dept. of Chemistry), F. H. Kruse (Los Alamos Scientific Lab., Univ. of California, N. Mex.), and D. W. Scott (Bureau of Mines, Bartlesville, Okla. Bartlesville Petroleum Research Center). [1962]. Contract [W-7405-eng-36]. 16p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

Far infrared spectroscopy and a normal-coordinate analysis for tetramethyllead yielded the first vibrational assignment consistent with the observed entropy of the vapor. The apparent entropy discrepancy with previous assignments was shown to result from use of liquid-state values for the low C−Pb−C bending frequencies in calculating the vapor-state entropy. A table of the chemical thermodynamic properties of tetramethyllead at selected temperatures was prepared. (auth)

19436 (SC-DC-64-1154) SILICON MONOLITHIC RANDOM PULSE GENERATOR. L. Wang, H. Robertson, and K. K. Schuegraf (Westinghouse Electric Corp., Newbury Park, Calif. Molecular Electronics Div.). [Oct. 1964]. For Sandia Corp., Albuquerque, N. Mex. Contract AT(29-1)-789. 19p. (CONF-793-3). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Electron Devices Meeting, Washington, D. C., Oct. 1964.

A technique is described for fabricating a monolithic Si subsystem incorporating 17 identical logic NAND gates. (T.F.H.)

19437 (SC-DR-64-1782) DIFFERENTIAL THERMAL ANALYSIS OF FLEXIBLE POLYURETHANE FOAMS. I. TRANSITIONS AND THEIR EFFECT ON STRESS-STRAIN PROPERTIES. Peter B. Rand (Sandia Corp., Albuquerque, N. Mex.). Jan. 1965. Contract [AT(29-1)-789]. 22p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The glass transition temperatures (T_g) of four flexible polyurethane foams were determined by differential thermal analysis. Glass transition temperatures were also determined from stress-strain curves obtained over a temperature range of −57°C to 22°C and compared with DTA values. (auth)

19438 (SC-M-65-79) TABLE OF 20,000 GEAR RATIOS 1.0000 TO 3.0000. R. L. Lachance and F. O. Lane (Sandia Corp., Albuquerque, N. Mex.). Feb. 1965. Contract AT(29-1)-789. 202p. Dep.; $6.00(cy), 6(mn) CFSTI.

A series of twenty thousand ratios was compiled primarily for a filament winding machine with a three-step transmission system. (auth)

19439 (SC-R-64-1311) A COMPILATION OF LONGITUDINAL AERODYNAMIC CHARACTERISTICS INCLUDING PRESSURE INFORMATION FOR SHARP- AND BLUNT-NOSE CONES HAVING FLAT AND MODIFIED BASES. A. D. Foster, comp. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1965. Contract AT(29-1)-789. 592p. Dep.; $8.96(cy), 13(mn) CFSTI.

Sandia Corporation Monograph.

Only a limited amount of aerodynamic information is available on generalized cone geometries over a wide range of Mach number and angle of attack. An accumulation of a large amount of these unclassified cone stability and pressure data by order of the cone half-angle is presented. Both experimental and theoretical data are included. A bibliography is also included which consists of several references to sources containing theoretical and/or experimental data on the aerodynamic characteristics of cones. (auth)

19440 (SC-TM-65-5) IMPROVED PACKAGING OF ELECTRONIC AND ELECTROMAGNETIC PARTS. L. J. O'Connell (Sandia Corp., Albuquerque, N. Mex.). Jan. 1965. Contract AT(29-1)-789. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A new way of mounting electronic and electromagnetic parts inside panel chassis assemblies has been developed. The new method offers prospects for reduced wiring harness sizes, better convection paths for heat dissipation, less crosstalk within the unit, easier and speedier fabrication, simpler trouble shooting, and more satisfactory location of parts that belong together. (auth)

19441 (SCL-DR-64-117) CLAMP-ON DIRECT-CURRENT MONITOR. E. E. Skidgel (Sandia Corp., Livermore, Calif.). Mar. 1965. Contract AT(29-1)-789. 18p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A simple clamp-on direct-current measuring module, based on the Hall effect principle, is stable and reliable throughout the normal telemetry environment and is capable of measuring direct current without interrupting the circuit being monitored. (auth)

19442 (TID-20546) THE MIGRATION OF INTERSTITIAL ATOMS IN GOLD. I. EXPERIMENTAL. J. A. Venables and R. W. Balluffi (Illinois Univ., Urbana. Materials Research Lab.; Illinois Univ., Urbana. Dept. of Physics; and Illinois Univ., Urbana. Dept. of Mining, Metallurgy, and Petroleum Engineering). [1963]. Contract [AT(11-1)-1198]. 34p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Direct information about the migration energy of single interstitial atoms in gold was obtained using a combination of low energy ion bombardment and transmission electron microscope techniques. Both annealed and quenched gold foils, containing vacancy tetrahedra, were bombarded with 200-ev argon ions inside an electron microscope at temperatures between −130 and 30°C. The foils were observed both at the bombardment temperature and during subsequent annealing. The bombardment produced focused replacement sequences which deposited interstitials about 100 Å beneath the incident surface. By observation of the formation of interstitial clusters and of the removal of vacancy tetrahedra by the interstitials as a function of temperature and foil thickness, it was deduced that single interstitials begin to migrate over distances of several hundred Å only above 0°C. This implies that the energy of migration of this interstitial is not less than 0.7 ev. (auth)

19443 (TID-20565) THE MIGRATION ENERGY OF INTERSTITIAL ATOMS IN GOLD. II. ANALYSIS AND INTERPRETATION OF EXPERIMENTS. J. A. Venables and R. W. Balluffi (Illinois Univ., Urbana. Materials Research Lab.; Illinois Univ., Urbana. Dept. of Physics,; and Illinois Univ., Urbana. Dept. of Mining, Metallurgy, and Petroleum Engineering). [1964]. Contract [AT(11-1)-1198]. 44p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A quantitative analysis of the low energy ion-bombardment experiments on gold is shown to yield values for the interstitial diffusion coefficient, the migration energy of the interstitial, and the binding energy of small interstitial clusters. All the experiments are shown to have a self-consistent interpretation in terms of the migration of a single interstitial, which becomes mobile near 0°C with a migration energy of 0.75 ± 0.06 ev. (auth)

19444 (TID-21650) THE PHOTOCHEMISTRY OF LIQUID CARBON TETRACHLORIDE (thesis). Herbert B. Silber (Lehigh Univ., Bethlehem, Pa.). 1964. Contract AT(30-1)-2772. 130p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

The competition between the diffusion-controlled free radical combination to form C_2Cl_6 and the non-diffusion-controlled Cl_2 scavenging reaction for $\cdot CCl_3$ was characterized through the use of cells with a path length of the order of 1.75 cm and microcells with a 1 mm path length. Using the large cells, the initial quantum yield for C_2Cl_6 formation was about 5 times less than with the microcells. This difference is ascribed to the presence of $\cdot CCl_3$ radical concentration gradients in the large cell, permitting $\cdot CCl_3$ to diffuse from a region of high radical concentration to one of low radical concentration, where the probability of reaction with the Cl_2 is increased. Microcell light absorption was more uniform and therefore there were no concentration gradients present. Although the irradiations were not carried to a high enough total dose, the data indicates that the steady state plateau occurs at a concentration about 3 times higher in the microcells than in the large cells, even though the light intensity per unit area was 5 times greater in the large cells than the microcells. (auth)

19445 (TID-21660) THE THERMODYNAMICS AND KINETICS OF COORDINATION COMPOUNDS. Progress Report. Michael Cefola and Philip S. Gentile (Fordham Univ., New York). Feb. 4, 1965. Contract AT(30-1)-906. 55p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Some of the techniques which will be used in nuclear magnetic resonance studies of the enol-keto equilibrium in acetyl-acetone, are described. The Szilard-Chalmers effect in the slow and fast neutron irradiation of praseodymium 1-phenyl-1,3-butanedione chelate was studied using extraction from $CHCl_3$ into aqueous phase, and the formation of ^{142}Pr was noted. The preparation of $Pr(TTA)_4$ is reported. Work is continuing on the reaction of pyridine and other heterocyclic amines with HIO_3 + HCl, with the resulting formation of complexes of the type Py · HCl · ICl. The kinetics of the reaction of Ni^{2+} and acetylacetone to form the monoacetylacetonato complex were studied. The solvent effects in the kinetics of formation of monoacetylacetonato copper(II) were also studied. Two studies of the use of solid-solid interactions to prepare complexes are reported, in which 5 uranyl nitrate-urea complexes and 24 chelates between diacetamide and alkali and alkaline earth metal salts were obtained. The effects of dielectric constant and temperature on the stepwise formation of Ni(II) and Co(II) acetylacetonates in CH_3OH-H_2O and $C_3H_7OH-H_2O$ mixtures were studied. (D.L.C.)

19446 (UCRL-10702(Rev.)) THE ACTIVATION ENERGY FOR THE SUBLIMATION OF GALLIUM NITRIDE. Zuhair A. Munir and Alan W. Searcy (Lawrence Radiation Lab., Univ. of California, Berkeley). Dec. 31, 1964. Contract W-7405-eng-48. 22p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Gallium nitride was found to sublime congruently from a torsion-effusion cell when the ratio of orifice area to sample area was about $1/30$ and incongruently to yield nitrogen gas and liquid gallium when this ratio was about $1/100$ or less. A mass spectrometer investigation revealed no measurable concentrations of gallium nitride vapor molecules. The heat of activation for the reaction $2GaN(s) = 2Ga(l) + N_2(g)$ was calculated to be 39 kcal at 1300°K from the temperature dependence of the effusion data. The rate

of the reaction $2GaN(s) = 2Ga(g) + N_2(g)$ was measured by a torsion-Langmuir method. From the temperature dependence of sublimation, the heat of activation for this reaction was calculated to be $\Delta H_{1300} = 218.6$ kcal compared to 173 kcal for the equilibrium reaction, and the entropy of activation was calculated to be 74.3 cal/deg. (auth)

19447 (UCRL-11290) EFFECT OF STRAIN-HARDENING ON THE LOWER TEMPERATURE THERMALLY-ACTIVATED DEFORMATION MECHANISMS IN POLYCRYSTALLINE ALUMINUM. A. C. Nunes, Jr., A. Rosen, and J. E. Dorn (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 18, 1964. Contract W-7405-eng-48. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The low-temperature thermally activated deformation mechanisms in polycrystalline aluminum are investigated through measurements of flow stress vs temperature for states of varying strain-hardening. At low temperatures, the results are in nominal agreement with the intersection mechanism. At higher temperatures, an almost athermal region is encountered, although a thermal recovery mechanism appears to operate within this temperature range. (auth)

19448 (UCRL-11782) INTERSTITIAL ORDERING OF CARBON IN TANTALUM (thesis). Robert Emerick Villagrana (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 1965. Contract W-7405-eng-48. 44p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The effect of interstitial carbon in tantalum was investigated by transmission electron microscopy and selected area diffraction. Interstitial ordering was found, and the ordered structure was determined from computation and comparison with electron diffraction data. The superlattice structure is tetragonal, with a c/a ratio of 1.128, and an ideal composition $Ta_{64}C$. Since the superlattice was determined from thin foils, it was necessary to compare the thin foil results with bulk specimens, alloyed to correspond to $Ta_{64}C$. Microscopic examination of bulk specimens showed many domain boundaries, separating regions in which the tetragonality associated with ordering was oriented in different directions. An analysis of these domain boundaries indicates that there are three possible types: coherent, semicoherent, and antiphase. (auth)

19449 (UCRL-11928) DETERMINATION OF THE ORDERING IN THE INTERMETALLIC COMPOUND Ag_2Al BY MEANS OF X RAYS (thesis). Joachim P. Neumann (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 28, 1965. Contract W-7405-eng-48. 63p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

In order to verify the predicted short-range ordering in the intermetallic hexagonal phase Ag_2Al, the diffuse intensity diffracted from single crystals of this alloy was measured in several directions in reciprocal space. On crystals annealed for 10 days at 453°K, the first Cowley-Warren pair-density coefficient was found to be approximately −0.20. The tendency toward the formation of a two-dimensional superlattice on the basal planes is indicated, in which each aluminum atom is surrounded by six silver atoms. The measurements were carried out in vacuum at approximately 300°K and 150°K, using crystal monochromated MoK_α-radiation. The proposed model of the superlattice is based on the appearance of short-range order peaks at $\frac{1}{3}$ and $\frac{2}{3}$ the distance from the (110) line. Weak but sharp lines of the type (001), (003) can be explained by an average composition difference of 1 at. % in consecutive basal planes, extending over many layers. No explanation can yet be given for the simultaneous existence of long-range and short-range order. The c-parameter of the annealed alloy was found to be 0.06A larger than the value reported for the quenched alloy, indicating a different atomic arrangement in the two states. (auth)

19450 (Y-KE-179) NUMERICALLY CONTROLLED GAGING. T. E. Douglass (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 4, 1965. Contract W-7405-eng-26. 14p. (CONF-650307-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Ordnance Assn. Meeting, Philadelphia.

A discussion of the experience with tape-controlled inspection machines is presented with respect to the economic justifications of such machines. It is concluded that they are justified if they increase inspection productivity, increase accuracy and precision, lower maintenance expenses and training costs, or eliminate special-purpose gaging requirements. (D.L.C.)

19451 (JPRS-28496) TRANSLATIONS ON COMMUNIST CHINA'S SCIENCE AND TECHNOLOGY NO. 140. [1964]. 58p. (TT-65-30212). $3.00(CFSTI).

For an abstract of the individual paper see: 18756.

19452 (OTS-64-11459/2) TRANSACTIONS [OF THE] INSTITUT ZA VODOPRIVREDU "JAROSLAV CERNI." Translation of "Saopstenja Instituta za Vodoprivredu "Jaroslav Cerni," 9: No. 31, 1964. 69p. $3.00(CFSTI).

Seven papers are presented on the following topics: geotechnical studies at site of proposed hydroelectric power plant, model testing in hydrotechnical structural problems, tracer studies of bed load movements in rivers, nonsteady discharges due to hydroelectric plant operation, filtration across a cellular cofferdam and an earth dam, hydraulic studies of a navigation lock, and reclamation of saturated clay soil. A separate abstract was prepared of the paper on tracer studies of bed load movements in rivers. (D.L.C.)

For an abstract of the individual paper see: 18178.

19453 ELEVENTH SEMIANNUAL REPORT TO CONGRESS, JANUARY 1–JUNE 30, 1964. (National Aeronautics and Space Administration, Washington, D. C.). 1964. 263p. $1.00(GPO).

The projects and progress of the National Aeronautics and Space Administration for the period of Jan. 1, 1964 to June 30, 1964 are reported. Topics covered include: manned space flight, scientific investigations in space, satellite applications, advanced research and technology, nuclear propulsion and power generation, tracking and data acquisition, international programs, grants and research contracts activities, informational and educational programs, and personnel, management, procurement, and support functions. The SNAP-8 development project, nuclear electric power research, electric rocket program and the nuclear rocket program are discussed. (M.C.G.)

19454 SEMICONDUCTOR BISTABLE CIRCUIT WITH INTEGRAL GATE. W. J. Poppelbaum and N. E. Wiseman (to U. S. Atomic Energy Commission). U. S. Patent 3,171,037. Feb. 23, 1965.

A bistable flip-flop circuit integral with its gate circuit is described. The gate is normally part of the feedback loop, but upon receipt of a gating signal, it opens the loop so that the flip-flop may be set according to the input information received. (AEC)

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
ø		oe
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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
  Al–Cr ...
CHROMIUM ALLOYS
  Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
  Si–W ...
TUNGSTEN SYSTEMS
  Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium—allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

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606163	19-17849	See AFWL-TDR-64-44
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8019	19-19100	Ann. Phys. (N. Y.), 31: 88-99(1965)
8058	19-19103	Ann. Rev. Nucl. Sci., 14: 51-100(1964)
8126	19-19071	Nucl. Sci. Eng., 21: 304-11(1965)
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8666	19-18513	Phys. Rev., 138: A577-83(1965)
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CM–	**(Misc.)**	
1046	19-18967	See NP-14826
CONF-36–	**(American Physical Society 1962 Annual Meeting, New York, Jan. 1962)**	
4	19-17951	See AROD-62-8
CONF-105–	**(17th Atomic Energy Commission Metallography Group Meeting, Los Alamos, N. Mex., May 1963)**	
2	19-18452	See EURAEC-996
CONF-378–	19-18096	**(43rd Annual Meeting, Highway Research Board, Washington, D. C., Jan. 1964)**
CONF-543–	**(American Physical Society 1964 March Meeting, Philadelphia, Mar. 1964)**	
21	19-19324	ORINS. Gmelin, AED-CONF-64-028-40
CONF-554–	**(Cryogenic Engineering Conference, Philadelphia, Aug. 1964)**	
14	19-18105	ORINS. Gmelin, AED-CONF-64-142-9
CONF-603–	**(Transaction of Meeting, Vacuum Metallurgy, American Vacuum Society, New York, June–July 1964)**	
9	19-18408	ORINS. Gmelin, AED-CONF-64-109-10
CONF-617–	**(Special Technical Conference on Nuclear Radiation Effects, Seattle, Wash., July 1964)**	
16	19-18348	ORINS. Gmelin, AED-CONF-64-116-33
CONF-651–	**(9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug. 31–Sept. 4, 1964)**	
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51	19-18091	ORINS
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CONF-773–	**(Symposium on Chemical Effects Associated with Nuclear Reactions and Radioactive Transformation, Vienna, Dec. 1964)**	
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37	19-17958	See PAN-577/V
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CONF-640615–	**(Fast Reactor Physics Conference, Ann Arbor, Mich., June 8–12, 1964)**	
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CONF-640616–	19-19002	(Symposium on Ultra Low Frequency Electromagnetic Fields, Tokyo, June 1964)
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1	19-18234	See EUR-CEA-FC-281
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CONF-641017–		(Symposium on Low Energy X and Gamma Sources and Applications, Chicago, Oct. 20–21, 1964)
4	19-18340	ORINS. Gmelin, AED-CONF-64-221-6
CONF-641108–		(American Physical Society, New York, Nov. 4–8, 1964)
10	19-19233	See GA-6106
CONF-641113–	19-17445	(6th International Transplantation Conference on Transplantation, New York, Nov. 1964)
CONF-641116–		(Conference on the Role of Grain Boundaries and Surfaces in Ceramics, Raleigh, N. C., Nov. 16–18, 1964)
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CONF-641208–		(3rd Conference on Performance of High Temperature Systems, Pasadena, Calif., Dec. 1964)
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CONF-641212–		(Symposium on the Mineralogy of Carbonatites and Alkaline Ultrabasic Rocks, New Delhi, India, Dec. 1964)
1	19-18137	See EUR-2110.e
CONF-650103–		(International Symposium on Packaging and Transportation of Radioactive Material, Albuquerque, N. Mex., Jan. 11, 1965)
4	19-18193	See HW-SA-3995
CONF-650104–		(Conference on Nucleosynthesis, New York, Jan. 25–26, 1965)
1	19-18093	See LA-DC-6897
CONF-650108–		(AIAA 2nd Aerospace Sciences Meeting, New York, Jan. 25–27, 1965)
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19	19-18130	ORINS
CONF-650109–		(Golden Gate Section of the Society for Nondestructive Testing in San Francisco, Jan. 13, 1965)
1	19-18131	See ACF-4
CONF-650204–		(Meeting on Thermocouple Technology and the Effects of Nuclear Radiation on Thermocouples, Washington, D. C., Feb. 24–26, 1965)
2	19-18344	See ORNL-P-1066
CONF-650208–		(International Symposium for Quantum Chemistry, Istanbul, Aug. 1964)
1	19-18681	See IS-1107
CONF-650301–		(Symposium on the Physics and Chemistry of Fission, Salzburg, Mar. 22–26, 1965)
5	19-19093	See UCRL-11902
CONF-650302–		(IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna, Mar. 1965)
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CONF-650307–		(American Ordnance Assn. Meeting, Philadelphia, Mar. 17–18, 1965)
1	19-19450	See Y-KE-179
CONF-650405–		(International Conference on Modern Trends in Activation Analysis, College Station, Tex., Apr. 19–22, 1965)
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CONF-650505–		(IFIP Congress 1965 Meeting, New York, May 24–29, 1965)
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CONF-650506–		(American Foundrymen's Society Meeting, Chicago, May 10–14, 1965)
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COO–		
30-96	19-18805	Nuova Cimento (10), 35: 700-2(1965)
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1197-11	19-17953	Dep.(mn); $5.00(cy), 4(mn) CFSTI
1198-235	19-19048	Phys. Rev. Letters, 14: 129-31(1965)
1199-4	19-18154	J. Appl. Meteorol., 3: 707-17(1964)
1233-18	19-19232	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1365-4	19-17996	J. Phys. Chem., 69: 1080-1(1965)
1365-5	19-17997	J. Phys. Chem., 69: 1081-2(1965)
1420-105	19-19191	Phys. Rev., 138: B51-7(1965)
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CRC–	(Canadian)	
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1838.d.f.i.n	19-18143	Dep.(mn)
1915.f	19-18560	See CEA-R-2608
2107.f	19-18192	Dep.(mn)
2110.e	19-18137	Dep.(mn)
2114.e	19-17941	Dep.(mn)
2137.i	19-18555	Ing. Nucl., 5: No. 2, 1–12(1964)
2139.d	19-17658	Z. Vererbungslehre, 95: 150-66(1964)
2165.i	19-17772	Dep.(mn)
2171.i	19-18378	Dep.(mn)
2203.f	19-17954	Dep.(mn)
2204.i	19-19328	Dep.(mn)
2208.f	19-19371	Dep.(mn)
2214.f	19-18424	Dep.(mn)
2219.e	19-17773	Dep.(mn)
2223.d	19-17942	Dep.(mn)
2225.d	19-18350	Dep.(mn)
2228.e	19-18452	See EURAEC-996
2264.d	19-18201	Arch. Tech. Messen, Lfg., 342: 149-52 (1964)
2302	19-18534	See EURAEC-1318
2308	19-19381	See EURAEC-1331
EUR-CEA–	**(European Atomic Energy Community)**	
FC-281	19-18234	Dep.(mn)
EURAEC–		
772	19-17854	Dep.(mn); $2.00(cy), 1(mn) CFSTI
990	19-18425	Dep.(mn); $2.00(cy), 1(mn) CFSTI
996	19-18452	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1215	19-18256	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1227	19-18426	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1248	19-18110	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1254	19-18453	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1271	19-18427	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1276	19-18454	Dep.(mn); $2.00(cy), 2(mn) CFSTI
1290	19-19356	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1292	19-19338	See BMI-X-10107
1302	19-19357	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1303	19-19358	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1316	19-19383	See GEAP-4768
1318	19-18534	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1326	19-18111	See GEAP-4778
1327	19-18108	See BAW-3238-6
1331	19-19381	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1336	19-18450	See COO-578-P27-4
EURATOM–		
18	19-19357	See EURAEC-1302
19	19-19358	See EURAEC-1303
FTD-TT–	**(Non-AEC)**	
64-371	19-18470	CFSTI
64-395	19-18121	$1.00(cy), 1(mn) CFSTI as AD-609136
64-1316	19-18970	
FZK–	**(Non-AEC)**	
188-1	19-18535	
196	19-18536	CFSTI
GA–	**(Misc.)**	
5691	19-17832	Nucl. Instr. Methods, 33: 277-82(1965)
5702	19-17831	Nucl. Instr. Methods, 33: 273-6(1965)
5885	19-19083	
6106	19-19233	
GEAP–	**(Misc.)**	
4490	19-17774	Dep.; $3.00(cy), 2(mn) CFSTI
4714	19-19382	Dep.(mn); $4.00(cy), 3(mn) CFSTI
4768	19-19383	Dep.(mn); $2.00(cy), 1(mn) CFSTI
4777	19-18428	Dep.(mn); $2.00(cy), 1(mn) CFSTI
4778	19-18111	Dep.(mn); $3.00(cy), 2(mn) CFSTI
GEMP–	**(Misc.)**	
43A	19-18390	Dep.; $3.00(CFSTI)
GLR–		
32	19-18119	See SAN-409-17
HASL–		
156	19-18144	Dep.; $1.75(cy), 2(mn) CFSTI
HNS–		
1229-57	19-17775	Dep.(mn); $2.00(cy), 1(mn) CFSTI
HPR–	**(Norwegian)**	
42	19-19384	Dep.(mn)
44	19-18257	Dep.(mn)
46	19-19385	Dep.(mn)
48	19-19386	Dep.(mn)
HW–		
48815	19-17776	Dep.(mn); $1.00(cy), 1(mn) CFSTI
79029	19-18048	Dep.(mn); $1.00(cy), 1(mn) CFSTI
79572	19-18735	Dep.(mn); $2.00(cy), 1(mn) CFSTI
80298	19-18049	Dep.(mn); $1.00(cy), 1(mn) CFSTI
80808	19-18455	Dep.; $2.00(cy), 1(mn) CFSTI
80814	19-19425	Dep.(mn); $1.00(cy), 1(mn) CFSTI
83299	19-18050	Dep.(mn); $1.00(cy), 1(mn) CFSTI
84105	19-19426	Dep.(mn); $1.00(cy), 1(mn) CFSTI
84250	19-18258	Dep.(mn); $1.00(cy), 1(mn) CFSTI
84440	19-19387	Dep.(mn); $1.00(cy), 1(mn) CFSTI
HW-SA–		
3378	19-18548	Nucl. Sci. Eng., 21: 312-18(1965)
3439	19-17855	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3454	19-17452	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3483	19-18391	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3541	19-18259	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3681	19-17829	Nature, 205: 790-1(1965)
3995	19-18193	Dep.(mn); $2.00(cy), 2(mn) CFSTI
IA–	**(Non-AEC)**	
948	19-19151	Nuovo Cimento (10), 35: 355-76(1965)
IITRI–	**(Misc.)**	
578P15-12	19-18039	Dep.; $3.00(cy), 2(mn) CFSTI
IMP-AEC–		
34	19-18680	Dep.(mn); $2.00(cy), 1(mn) CFSTI
IPP–	**(Non-AEC)**	
1/20	19-19234	
1/22	19-19235	Dep.(mn)
1/23	19-19236	Dep.(mn)
1/27	19-19237	Dep.(mn)
1/31	19-19238	Dep.(mn)
2/19	19-19239	Dep.(mn)
2/31	19-19240	Dep.(mn)
2/34	19-19241	Dep.(mn)
4/16	19-18135	Dep.(mn)
6/30	19-19242	Dep.(mn)
IS–		
958	19-17904	J. Inorg. Nucl. Chem., 27: 663-71(1965)
988	19-18483	J. Appl. Phys., 36: 1447-50(1965)
1012	19-19416	Dep.; $3.00(cy), 2(mn) CFSTI
1013	19-18512	Phys. Rev., 138: A507-14(1965)
1107	19-18681	Dep.(mn); $1.00(cy), 1(mn) CFSTI

Report No.	Abstract No.	Availability
1117	19-17777	Dep.(mn); $1.00(cy), 1(mn) CFSTI
IS-Trans–		
11	19-17864	Dep.(mn); $1.10(fs), $0.80(mf) JCL
ISS–	**(Italian)**	
64/21	19-19084	Dep.(mn)
64/34	19-18194	Dep.(mn)
64/37	19-18260	Dep.(mn)
64/38	19-18145	Dep.(mn)
64/40	19-18235	Dep.(mn)
JEN–	**(Spanish)**	
131-DF/1-42	19-19085	Dep.(mn)
143-DF/1-46	19-19086	Dep.(mn)
JINR–	**(Russian)**	
D-1925	19-18747	Dep.(mn)
P-1853	19-18631	Dep.(mn)
P-1934	19-18920	Dep.(mn)
P-1935	19-18921	Dep.(mn)
P-1936	19-18632	Dep.(mn)
P-1941	19-18748	Dep.(mn)
P-1954	19-18749	Dep.(mn)
JPRS–	**(Non-AEC)**	
28165	19-18403	$1.00(CFSTI)
28405	19-17495	$3.00(CFSTI)
28496	19-19451	$3.00(CFSTI)
28558	19-18149	$1.00(CFSTI)
28560	19-17453	$1.00(CFSTI)
28739	19-18472	$2.00(CFSTI)
28780(p.24-8)	19-17497	
28859	19-18473	$1.00(CFSTI)
K–		
1629	19-18736	Dep.; $1.00(cy), 1(mn) CFSTI
KAPL–		
3066	19-18429	Dep.(mn); $2.00(cy), 1(mn) CFSTI
3074	19-18098	Dep.(mn); $2.00(cy), 2(mn) CFSTI
KAPL-M–		
6433	19-18380	Dep.(mn); $3.00(cy), 2(mn) CFSTI
6436	19-18381	Dep.(mn); $1.00(cy), 1(mn) CFSTI
KR–	**(Norwegian)**	
85	19-18112	Dep.(mn)
KY–		
481	19-17780	Dep.; $2.00(cy), 1(mn) CFSTI
LA–		
3089	19-19433	Dep.(mn); $3.00(cy), 2(mn) CFSTI
3097	19-17778	Dep.; $0.50(cy), 1(mn) CFSTI
3114	19-18561	Dep.(mn); $3.00(cy), 2(mn) CFSTI
3137	19-19434	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3152	19-17779	Dep.; $1.00(cy), 1(mn) CFSTI
3167	19-18113	Dep.; $3.00(cy), 2(mn) CFSTI
3168	19-19372	Dep.; $3.00(cy), 2(mn) CFSTI
3182	19-18236	Dep.; $3.00(cy), 2(mn) CFSTI
3183	19-18392	Dep.; $3.00(cy), 1(mn) CFSTI
3197	19-18086	Dep.; $4.00(CFSTI)
LA-DC–		
6351	19-18379	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6352	19-19243	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6353	19-19244	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6382	19-18099	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6384	19-17454	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6396	19-18100	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6413	19-19435	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6493	19-17865	A. I. Ch. E. (Am. Inst. Chem. Engrs.) J., 11: 304-10(1965)
6502	19-19074	Nucl. Sci. Eng., 21: 390-401(1965)
6509(Rev.)	19-18975	J. Geophys. Res., 70: 1031-8(1965)
6646	19-18195	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6665	19-18562	Dep.(mn); $2.00(cy), 2(mn) CFSTI
6729	19-18489	J. Less-Common Metals, 8: 217-21(1965)
6755	19-19192	Phys. Rev., 138: B57-65(1965)
6767	19-18511	Phys. Rev., 138: A467-83(1965)
6772	19-18244	Rev. Sci. Instr., 36: 461-4(1965)
6802	19-18731	Phys. Rev. Letters, 14: 209-13(1965)
6808	19-18430	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6823	19-18331	Rev. Sci. Instr., 36: 563(1965)
6897	19-18093	Dep.(mn); $1.00(cy), 1(mn) CFSTI
LADC–		
4080	19-18653	Astrophys. J., Suppl. Ser., 11: 22-46(1965)
5156	19-18652	Astrophys. J., Suppl. Ser., 11: 1-21(1965)
5849	19-18524	Trans. Met. Soc. AIME, 233: 19-24(1965)
6300	19-18563	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6343	19-19102	Ann. Rev. Nucl. Sci., 14: 29-50(1964)
LGI–	**(Italian)**	
63/25	19-18564	Dep.(mn)
64/2	19-19245	Dep.(mn)
MATT–		
265	19-19298	Phys. Fluids, 8: 500-6(1965)
328	19-19246	Dep.(mn); $1.00(cy), 1(mn) CFSTI
MIT–	**(Misc.)**	
905-18	19-17982	J. Inorg. Nucl. Chem., 27: 527-33(1965)
1965-12	19-17883	Inorg. Chem., 4: 334-6(1965)
2073-2	19-19373	Dep.(mn); $3.00(cy), 1(mn) CFSTI
2073-3	19-19388	Dep.(mn); $2.00(cy), 1(mn) CFSTI
2098-82	19-18298	Nucl. Instr. Methods, 33: 199-212(1965)
2098-110	19-18886	Phys. Rev. Letters, 14: 238-9(1965)
2249-1	19-17856	Dep.(mn); $7.00(cy), 7(mn) CFSTI
3357-1	19-18114	Dep.(mn); $5.00(cy), 3(mn) CFSTI
MITNE–	**(Misc.)**	
44	19-17856	See MIT-2249-1
57	19-19373	See MIT-2073-2
58	19-19388	See MIT-2073-3
ML-TDR–	**(Non-AEC)**	
64-173(Pt.II)	19-18393	CFSTI
64-294	19-18394	CFSTI
64-317	19-19247	
MLM–		
1226-J	19-18499	J. Nucl. Mater., 15: 231-3(1965)
MMPP-FRPC–		
64-1	19-19064	Dep.(mn); $3.00(cy), 2(mn) CFSTI
MPI-PAE–	**(German)**	
P1/1/65	19-19248	Dep.(mn)
MRC-TSR–	**(Non-AEC)**	
420	19-18557	See AD-424952
MSAR–	**(Misc.)**	
65-28	19-18456	Dep.(mn); $2.00(cy), 2(mn) CFSTI
65-38	19-18457	Dep.(mn); $2.00(cy), 1(mn) CFSTI
N–	**(Misc.)**	
65-12620	19-18115	See NP-14607
65-16747	19-18459	See NASA-CR-54287
65-17199	19-18401	See WANL-PR(Q)-005
65-17455	19-18458	See NASA-CR-54286
NAA-SR–		
9287	19-19344	Dep.; $3.00(cy), 2(mn) CFSTI
9885	19-19408	Dep.; $3.00(cy), 1(mn) CFSTI
9894	19-19409	Dep.; $2.50(cy), 3(mn) CFSTI
9967	19-19345	Dep.; $3.00(cy), 1(mn) CFSTI
NAA-SR-Memo–		
9055	19-19087	Dep.(mn); $2.00(cy), 2(mn) CFSTI
NASA-CR–	**(Misc.)**	
54219	19-19410	
54261	19-19083	See GA-5885
54286	19-18458	$1.00(CFSTI)
54287	19-18459	$2.00(CFSTI)
54288	19-18401	See WANL-PR(Q)-005

Report No.	Abstract No.	Availability
NASA-TN–	**(Misc.)**	
D-2620	19-18537	$2.00(CFSTI)
D-2659	19-18682	$3.00(CFSTI)
D-2688	19-18395	$1.00(CFSTI)
D-2711	19-18538	$1.00(CFSTI)
D-2716	19-19249	$2.00(CFSTI)
D-2717	19-19250	$1.00(CFSTI)
NBS-TN–	**(Misc.)**	
217	19-18565	$0.55(GPO)
NIRL-R–	**(British)**	
74	19-18633	Dep.(mn); $1.00(BIS); 5s. (HMSO)
NMI–	**(Misc.)**	
1265	19-18460	Dep.(mn); $2.00(cy), 1(mn) CFSTI
NP–	**(AEC File No. for Non-AEC Reports)**	
14436(Rev.)	19-18966	
14607	19-18115	$2.00(cy), 1(mn) CFSTI
14614	19-18634	Dep.(mn)
14648	19-19389	Dep.(mn)
14685	19-18261	Dep.(mn)
14686	19-18262	Dep.(mn)
14689	19-19251	Dep.(mn)
14693	19-18116	Dep.(mn)
14706	19-18263	Dep.(mn)
14707	19-18040	Dep.(mn)
14710	19-18264	Dep.(mn)
14713	19-18265	Dep.(mn)
14717	19-19252	Dep.(mn)
14724	19-18266	Dep.(mn)
14725	19-19253	Dep.(mn)
14729	19-18267	Dep.(mn)
14766	19-18922	Dep.(mn)
14804	19-18134	$2.00(cy), 2(mn) CFSTI as AD-610656
14809	19-18172	
14810	19-17857	
14811	19-17766	
14812	19-18721	$1.00(cy), 1(mn) CFSTI as AD-609961
14815	19-17955	
14816	19-18117	$1.00(cy), 1(mn) CFSTI as AD-610013
14817	19-18750	$3.00(cy), 2(mn) CFSTI as AD-610076
14820	19-19254	
14821	19-18923	Dep.(mn)
14826	19-18967	
14830	19-18739	
14857	19-19255	Dep.(mn)
14858	19-18566	Dep.(mn)
14859	19-18683	Dep.(mn)
14871	19-19256	Dep.(mn)
NRL–	**(Misc.)**	
6221	19-18461	$3.00(CFSTI)
NYO–		
2007-8	19-17956	Dep.(mn); $2.00(cy), 1(mn) CFSTI
2394-14	19-18567	Dep.(mn); $1.00(cy), 1(mn) CFSTI
2910-8	19-19390	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3319-1	19-17684	Radiation Res., 24: 473-81(1965)
3399-08	19-18884	Phys. Rev. Letters, 14: 163-6(1965)
ORNL–		
3623	19-18051	Dep.; $3.00(cy), 2(mn) CFSTI
3704	19-19329	Dep.; $3.00(cy), 2(mn) CFSTI
3734	19-18751	Dep.; $1.00(cy), 1(mn) CFSTI
3742	19-18382	Dep.; $2.00(cy), 1(mn) CFSTI
3750	19-17781	Dep.; $5.00(cy), 3(mn) CFSTI
3759	19-19417	Dep.; $3.00(cy), 2(mn) CFSTI
3764	19-18396	Dep.; $3.00(cy), 2(mn) CFSTI
ORNL-NSIC–		
4	19-19340	Free(ORNL)
ORNL-P–	**(Misc.)**	
15	19-19293	Phys. Fluids, 8: 459-70(1965)
60	19-17655	Transplantation, 3: 155-60(1965)
61	19-18368	Nucl. Sci. Eng., 21: 403-6(1965)
154	19-17983	J. Inorg. Nucl. Chem., 27: 725-30(1965)
214	19-17903	J. Inorg. Nucl. Chem., 27: 559-68(1965)
334	19-18297	Nucl. Instr. Methods, 33: 194-8(1965)
460	19-17887	J. Appl. Phys., 36: 1367-70(1965)
519	19-19303	Phys. Fluids, 8: 544-6(1965)
705	19-17803	Anal. Chem., 37: 621-3(1965)
790	19-19185	Phys. Rev., 138: B20-5(1965)
802	19-17491	Dep.(mn); $2.00(cy), 1(mn) CFSTI
932	19-19307	Phys. Rev. Letters, 14: 131-3(1965)
966	19-17937	Phys. Rev. Letters, 14: 365-9(1965)
1066	19-18344	Dep.(mn); $1.00(cy), 1(mn) CFSTI
ORNL-RSIC–		
5	19-19330	Dep.; Free(ORNL)
ORNL-TM–		
984	19-19391	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1027	19-18052	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1033	19-19088	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1045	19-17767	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1061	19-17858	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1063	19-18462	Dep.(mn); $4.00(cy), 2(mn) CFSTI
1083	19-19018	Dep.(mn); $2.00(cy), 2(mn) CFSTI
ORNL-tr–		
460	19-18570	Dep.(mn); $7.60(fs), $2.42(mf) JCL
ORO–		
592	19-17782	Dep.; $2.00(cy), 1(mn) CFSTI
PAN–	**(Polish)**	
519/IX	19-18118	
570/II	19-18463	
575/IXA-V	19-18053	Dep.
576/V	19-17957	
577/V	19-17958	
599/VI	19-18464	
PATENTS	**(Canadian)**	
679,138	19-18374	
679,139	19-18045	
682,603	19-18375	
685,437	19-18082	
687,034	19-18228	
698,017	19-19326	
700,393	19-19369	
700,831	19-18443	
701,572	19-18189	
701,780	19-18376	
702,202	19-19348	
PATENTS	**(German)**	
1,176,765	19-18341	
1,181,827	19-18229	
1,181,837	19-18648	
1,183,324	19-18230	
1,183,419	19-19337	
PATENTS	**(U. S.)**	**$0.25 each, U. S. Patent Office**
3,154,377	19-18083	
3,155,454	19-18084	
3,155,455	19-18085	
3,156,636	19-18035	
3,156,819	19-17847	
3,156,821	19-18231	
3,170,841	19-19327	
3,170,843	19-19370	
3,170,844	19-19349	
3,170,846	19-19405	
3,170,847	19-19375	
3,170,884	19-18342	
3,171,025	19-18649	
3,171,037	19-19454	
3,171,714	19-18444	
3,171,715	19-18445	
3,171,815	19-18446	
3,174,818	19-18418	
PIBMRI–	**(Non-AEC)**	
1224-64	19-18740	$4.00(CFSTI)
POR–	**(Non-AEC)**	

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1809	19-18173	Dep.(mn); $2.00(cy), 1(mn) CFSTI
PPAD–		
527-E	19-18881	
530-E	19-19183	Phys. Rev., 138: B9-17(1965)
PWA–	**(Non-AEC)**	
2518	19-18465	
PWAC–	**(Misc.)**	
454	19-18237	Dep.; $2.00(cy), 1(mn) CFSTI
R–	**(Misc.)**	
2315	19-18256	See EURAEC-1215
2320	19-18453	See EURAEC-1254
64SD-72	19-19257	
RADC-TDR–	**(Misc.)**	
64-265	19-18740	See PIBMRI-1224-64
RDR–	**(Non-AEC)**	
1360-10	19-18394	See ML-TDR-64-294
REIC–	**(Misc.)**	
21(Add.)	19-18539	$5.00(CFSTI) as AD-267890
RL-SA–		
9	19-18054	Dep.(mn); $2.00(cy), 1(mn) CFSTI
RL-SEP–		
30	19-18397	Dep.; $4.00(cy), 2(mn) CFSTI
46	19-17783	Dep.; $3.00(cy), 1(mn) CFSTI
65	19-19427	Dep.(mn); $2.00(cy), 1(mn) CFSTI
RM–	**(Misc.)**	
4388	19-18968	$2.00(cy), 1(mn) CFSTI as AD-610954
RPI–	**(Misc.)**	
328-19	19-19359	Dep.(mn); $1.00(cy), 1(mn) CFSTI
2408-1	19-18398	Dep.(mn); $1.00(cy), 1(mn) CFSTI
RRA–	**(Misc.)**	
T44	19-19331	
RSIC–	**(Non-AEC)**	
333	19-19267	$1.00(cy), 1(mn) CFSTI as AD-609439
RTD-TR–	**(Non-AEC)**	
8-112(V)	19-18431	$2.00(cy), 1(mn) CFSTI as AD-611589
RTI–		
2513-T11	19-17782	See ORO-592
SAL–	**(Canadian)**	
4	19-19089	Dep.(mn)
SAN–		
409-17	19-18119	Dep.(mn); $2.00(cy), 1(mn) CFSTI
SC-DC–		
64-1154	19-19436	Dep.(mn); $1.00(cy), 1(mn) CFSTI
SC-DR–		
64-1782	19-19437	Dep.(mn); $1.00(cy), 1(mn) CFSTI
SC-M–		
65-79	19-19438	Dep.; $6.00(cy), 6(mn) CFSTI
SC-R–		
64-1311	19-19439	Dep.; $8.96(cy), 13(mn) CFSTI
SC-RR–		
65-28	19-18540	Dep.(mn); $1.00(cy), 1(mn) CFSTI
65-70	19-18094	Dep.; $3.00(cy), 1(mn) CFSTI
SC-TM–		
64-1742	19-17959	Dep.(mn); $1.00(cy), 1(mn) CFSTI
65-5	19-19440	Dep.(mn); $1.00(cy), 1(mn) CFSTI
65-31	19-18132	Dep.(mn); $2.00(cy), 1(mn) CFSTI

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SCL-DR–		
64-117	19-19441	Dep.(mn); $1.00(cy), 1(mn) CFSTI
SGAE-CH–	**(Austrian)**	
9/1964	19-17784	Dep.(mn)
11/1964	19-17785	Dep.(mn)
SLAC-PUB–		
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